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FINAL REPORT
LESSONS LEARNED
ADVANCED ATTACK HELICOPTER

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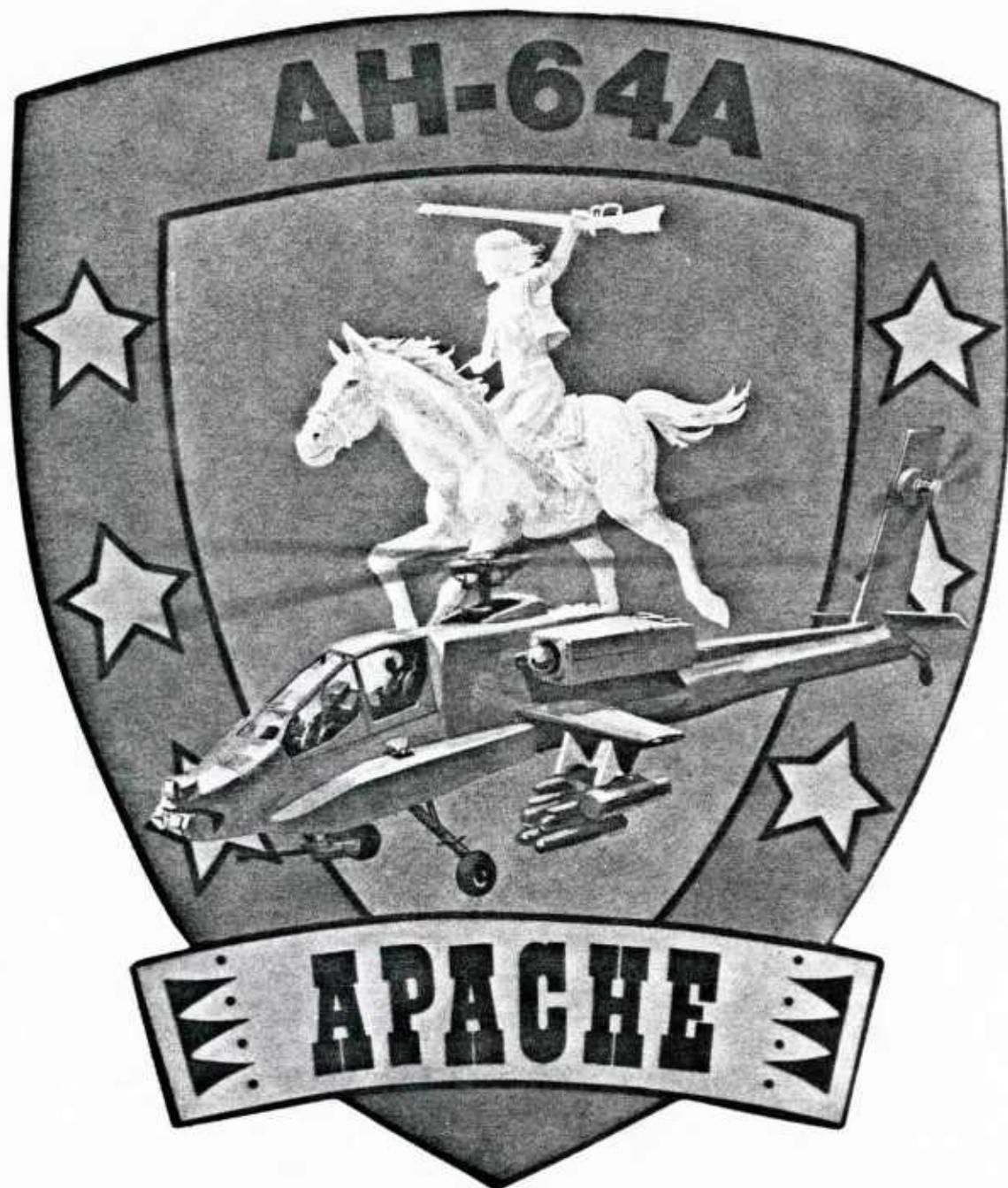
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LESSONS LEARNED ADVANCED ATTACK HELICOPTER

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Executive Summary

[to be provided]

FOREWORD

One of the contributors to the successful management of any defense systems acquisition project/program might well be the application of lessons learned from previous projects. The best sources for lessons learned are generally the personnel from the materiel development commands, project management offices, user community, contractors, and supporting organizations. The team that prepared this report on the AH-64A Advanced Attack Helicopter (Apache) System spoke with the personnel from these sources and recorded their observations and summarized the lessons learned for consideration by both present and future defense systems acquisition project/program managers and their staffs. The team realizes that to be effective, the lessons learned must be available to those who have a need to know and applicable to present or future projects/programs. Therefore, it is the hope of this team that its efforts and the experience gained on the AH-64A Program will be helpful to future defense systems acquisition project teams. If these teams learn from the Apache (commonly called AAH) Program experience the preparation of this report will have served a useful purpose.

The members of the team responsible for the preparation of this report are:

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The team is grateful to the AH-64 Program Manager, MG Edward M. Browne; the Deputy Program Manager, Mr. Bill Brabson,Jr.; and the other personnel on

the program team, as well as to the many Army and contractor personnel who provided the information and insights required to make this report of lessons learned possible.

The information and data contained herein are based upon the input available up to the time of its preparation in December 1982. This report represents the observations of the study team and the government and industry program/project management teams associated with the AAH. Although the HELLFIRE Modular Missile System is discussed in the report, it is done so only in the context of its integration in the total AAH weapons system. The investigation of lessons learned on the HELLFIRE program was not within the scope of this effort. No inferences, either pro or con, should be drawn from the wording of the observations regarding the AAH PMO performance in the activity discussed. How the particular event/activity was handled by the PMO is discussed in the "Background" section of each appendix. The report should not be construed to represent the official position of the DSMC, the US Army, or the AAH Program Office.

TABLE OF CONTENTS

<u>Section</u>		<u>Page</u>
EXECUTIVE SUMMARY
FOREWORD
I. INTRODUCTION		
A. Genesis of the Advanced Attack Helicopter	1	
B. Threat	5	
C. System Description	5	
1. General	5	
2. Organizational and Operational Concepts	9	
3. Support	10	
II. PROGRAM STRATEGY		
A. Overall Plan	11	
B. Acquisition Strategy	12	
1. General	12	
2. Advanced Attack Helicopter System	16	
III. PRINCIPAL LESSONS LEARNED		
A. Introduction	20	
B. Business Management	20	
C. Technical Management	21	
D. Test and Evaluation Management	21	
E. Integrated Logistics Support Management	22	
F. General Observations	23	

LIST OF APPENDICES

<u>Appendix</u>		<u>Page</u>
A. PROGRAM ORGANIZATION	A-1	
B. HISTORY OF THE AH-64A ADVANCED ATTACK HELICOPTER PROGRAM	B-1	
C. PROGRAM REVIEWS AND REDIRECTIONS	C-1	
D. BUSINESS MANAGEMENT	D-1	
E. TECHNICAL MANAGEMENT	E-1	
F. TEST AND EVALUATION MANAGEMENT	F-1	
G. INTEGRATED LOGISTIC SUPPORT MANAGEMENT	G-1	
H. GENERAL OBSERVATIONS	H-1	
I. REFERENCES	I-1	
J. GLOSSARY OF ACRONYMS	J-1	
K. STUDY TEAM COMPOSITION	K-1	

LIST OF FIGURES

<u>Figure</u>		<u>Page</u>
I-1	Evolution of Attack Helicopter Mission	3
I-2	Evolution of Attack Helicopter Requirements	4
I-3	AH-64A Advanced Attack Helicopter (APACHE)	6
I-4	Armament Subsystems	8
II-1	Advanced Attack Helicopter Program Milestones	13
II-2	Advanced Attack Helicopter Planned Acquisition Schedule - 1972	14
II-3	Advanced Attack Helicopter Acquisition Schedule - 1982.	15
A-1	Overall Organization For The Advanced Attack Helicopter	A-2
A-2	Organization of Advanced Attack Helicopter Program Office	A-3
A-3	Organization of HELLFIRE/Ground Laser Designator Project Office	A-4
D-1	Design-to-Cost Growth	D-7
D-2	Design-to-Cost Flyaway Estimate	D-8
E-1	AAH Characteristics - 1972 RFP	E-1
E-2	AAH Minimum Essential Performance Goals, "Floor Parameters"	E-3
E-3	Hughes Helicopter Development Team - 1973	E-4
E-4	Phase 1 Program Cost/Schedule Changes	E-7
E-5	AAH Working Groups	E-10
E-6	Army AAH Community	E-11
E-7	Program for Transition to Production	E-13
E-8	Configuration Milestones	E-14
E-9	Major AAH Contractors - 1982	E-16
E-10	AAH Major Production Milestones	E-17
E-11	AAH Program Production Schedule	E-17
F-1	Test and Evaluation Program	F-2
G-1	Phase 2 ILS RDT&E Funding	G-8

I. INTRODUCTION

A. GENESIS OF THE ADVANCED ATTACK HELICOPTER

The initial studies by the Army regarding the use of the helicopter as a weapons platform began in 1955. In 1956, the Commandant of the Aviation School directed a survey of the use of helicopters in combat. Based on the results of this survey the Army Deputy Chief of Staff for Operations recommended arming existing H-13, H-21, and H-34 helicopters with single 7.62 machine guns. In March 1958 an Aerial Combat Reconnaissance Company, equipped with armed helicopters, was organized at Ft. Rucker, Alabama.

Early in the Vietnam War the potential role of helicopters in combat became apparent and, by 1962, the first U.S. Army armed helicopters were used in an escort role. In 1962 Secretary of Defense (SECDEF) Robert McNamara, dissatisfied with the Army's tactical mobility, recommended the Army re-examine its aviation requirements. In response to the SECDEF's recommendation, the Army organized the U.S. Army Tactical Mobility Requirements Board, known as the Howze Board. The Board established a requirement for a helicopter capable of protecting troop carrying helicopters during flight and providing fire support in ground operations. Both the U.S. Army Materiel Command (AMC) and the U.S. Army Combat Developments Command (CDC) supported procurement of an interim off-the-shelf helicopter for meeting the requirement. However, the Secretary of the Army (SA) disapproved this interim approach and directed the Army staff to look at a more advanced system. In 1963, CDC developed a draft Qualitative Military Development Objective (QMDO) for a new armed helicopter.

In March 1964 the Project Manager for the Advanced Aerial Fire Support System (AAFSS) was tasked to coordinate efforts to study the state of the art for armed rotary winged aircraft. As a result of these studies the Army recognized the requirement for a new aircraft system to meet the AAFSS need. During the next two years (1964-1966), the issues of the attack helicopter program centered around two choices: use of an interim aircraft such as proposed by Bell and/or development of a much more advanced system. The Army decided to proceed with both courses of action.

Following flight evaluations by the Aviation Test Activity of several candidate helicopters, the Army selected the COBRA, AH-1G, helicopter as its interim attack helicopter. In April 1966, Bell Helicopter Company was awarded a contract for 110 AH-1G helicopters. By the end of FY70, a total of 711 COBRA helicopters had been produced and were in the Army inventory.

In response to the need to develop a more advanced attack helicopter, the Army issued a Request for Proposal (RFP) in August 1964 for the Program Definition Phase of AAFSS. In February 1965, competitive contracts for the design of an AAFSS were awarded to Lockheed Aircraft Company and the Sikorsky Aircraft Division of United Aircraft Corporation. Program definition efforts began in March 1965.

Both contractors submitted fixed priced incentive proposals for development and a firm fixed price proposal for production of the AAFSS in September 1965. In March 1966, the Engineering Development Contract was awarded to Lockheed for fabrication of ten prototypes. The contract was essentially a Total Package Procurement with the exception that it contained options for production rather than the terms of production. In January 1968, the

Government exercised an option to procure the first increment of a total procurement of 375 AH-56As (CHEYENNE). However, the AH-56A production contract was terminated for default in May 1969 before it was definitized.

During the next two years the Army and Lockheed were involved in the settlement of the production contract and litigation and restructuring of the development contract. The year 1971 ended without a production contract for an attack helicopter.

In January 1972, the Department of the Army established the Advanced Attack Helicopter Task Force (AAHTF). The task force report, submitted to the SA in August 1972, identified the capabilities desired in an Advanced Attack Helicopter which could be available in the late 1970s. Basically, the desired aircraft would be more agile, smaller, somewhat slower, and would have less sophisticated fire control and navigation equipment than the requirement against which the Cheyenne was developed. As a result the SA terminated the CHEYENNE program in August 1972. Figures I-1 and I-2 summarize the evolution of the attack helicopter missions and requirement.

1964	OMDO	Aerial Weapons Platform
1965	QMR	Escort Troop Helicopters and Provide Suppressive Fires
1968	HQDA Ltr.	Provide Direct Fire Support to Army Forces
1972	AAHTF (MN)	Provide Antiarmor Protection With Air Cavalry and Airmobile Escort as Secondary Missions.

Figure I-1

EVOLUTION OF ATTACK HELICOPTER MISSION

Requirement	1964 QMDO	1965 QMR	1972 MN 1973 DCP	Remarks
Vertical Performance	HOGE, 6000'/95°F	HOGE, 5000'/90°F 2000 FPM Climb rate	HOGE, 4000'/95°F 450 FPM Climb rate	Requirement now meets 85% operational capability over 90% of world at mission gross weight.
Night Vision	Not Specified	Gunner Only	Pilot and Gunner (Independent Systems)	Required for low level night operations
Armament	Capable of attacking lightly armored/heavy armor point targets; dispersed personnel, and vehicles at 100-2500M	40mm/7.62 gun system 30mm gun TOW	2.75 in Rocket 30mm Gun TOW	TOW changed to HELLFIRE in 1976
Air Speed	Cruise 195 Knots Dash 220 Knots	Cruise - 195 Knots	Cruise - 145 Knots	High speed in anti-armor role not critical
Ferry Range	1000 NM	1500 NM	800 NM	Self-deployment no longer required
Navigation	Available standard tactical communication and navigation equipment	Accuracy 0.5% x distance, provisions for automode	LORAN only	Sophisticated and expensive automodes and self navigation not required
Engine	Turbine Engine(s)	Turbine Engine(s)	Two engines	Survivability
Payload/Endurance	1500 lbs. armament and ammunition/3 hrs.	1500 lbs for 3 hrs.	1300 lbs for 1.9 hrs. (Changed to 1.83 hrs w/change to HELLFIRE)	Antiarmor mission lessens payload/endurance requirements
Maneuverability, Stability, Handling, Qualities	Maximum at 0-100 Knots	Maximum at 0-100 Knots	Optimized for mid-low speed	Increases survivability

Figure I-2

EVOLUTION OF ATTACK HELICOPTER REQUIREMENTS

On 28 September 1972, the Army proposed the AAH as defined by the MN to the Defense Systems Acquisition Review Council (DSARC). The proposal that was presented called for two contractors to build two flying prototypes of the AAH. The estimated Design-To-Unit-Production-Cost (DTUPC) of \$2.0 to \$2.4 million was considered too costly by the Office of the Secretary of Defense (OSD). In May 1973 the AAH Development Concept Paper (DCP) with the Army's reduced design-to-cost of \$1.6 million was approved by the DEPSECDEF. The lower DTC was achieved by reducing the requirements, not pushing the state-of-the-art as much as planned, and using a modified rather than a new optimum TOW system.

B. THREAT

In developing the MN for the AAH, the AAHTF considered two elements of Soviet combat power and doctrine. The first consideration was the Soviet reliance on their highly mobile armor and mechanized units. The second consideration was the progress of the Soviet tactical air defense. Considering the numerically superior Soviet and Warsaw Pact armor and mechanized forces operating under the cover of tactical aircraft, the need for a weapon system to react rapidly and effectively to developing situations was evident. The "new start" AAH would provide such a responsive weapon system.

C. SYSTEM DESCRIPTION

1. General. The AH-64 (AAH) or APACHE is a two-place, tandem-seat, twin engine helicopter with four-bladed main and anti-torque rotors (see Figure I-3). The tandem seating arrangement is used to minimize frontal area. The copilot/gunner is located in the forward cockpit to maximize target acquisi-

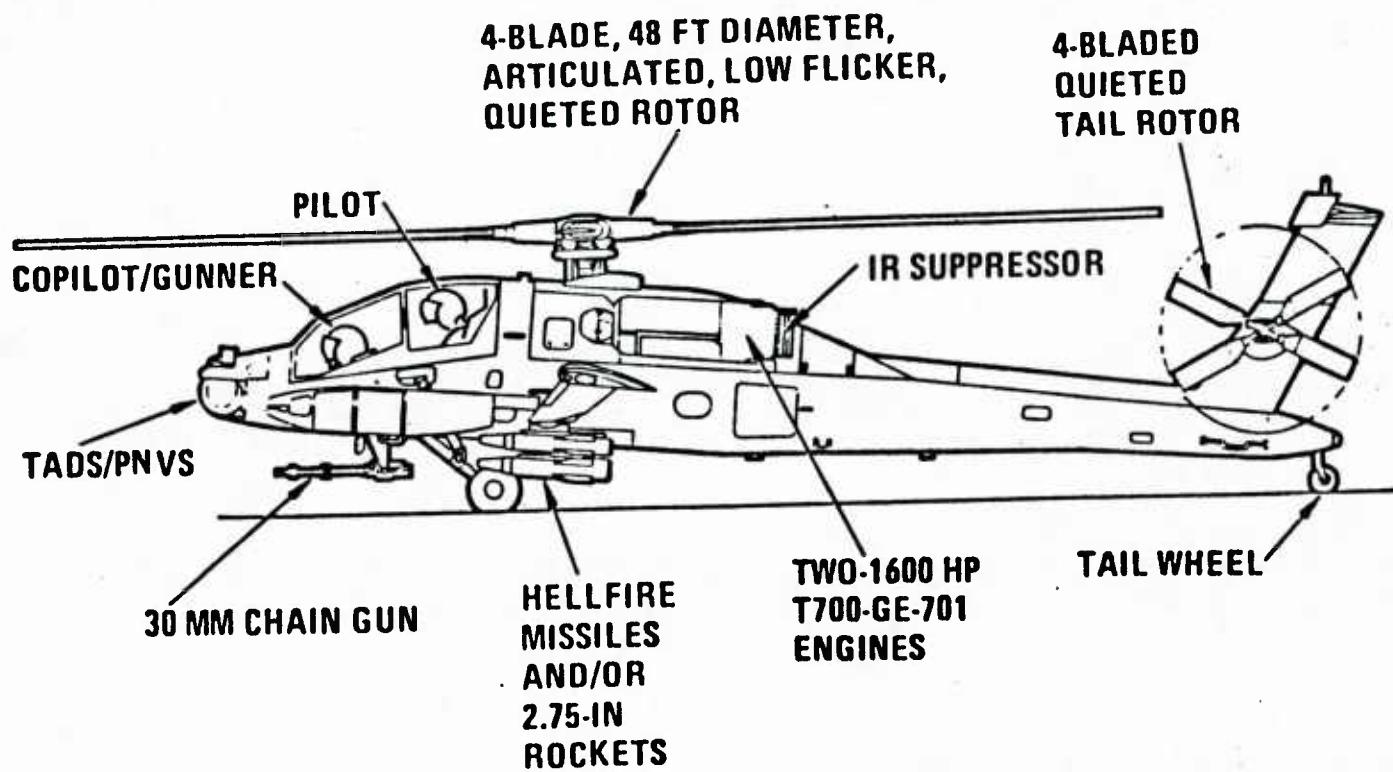


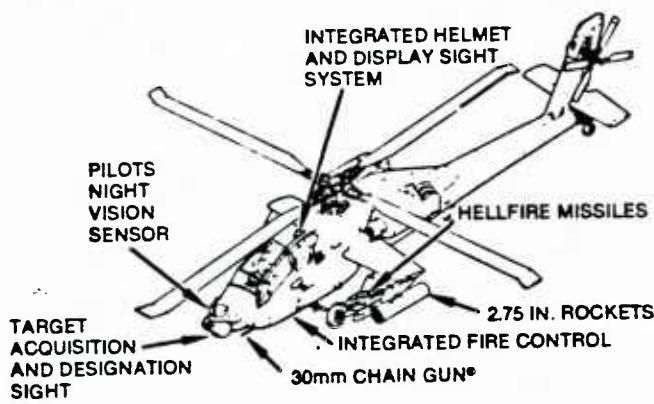
Figure I-3

AH-64A ADVANCED ATTACK HELICOPTER (APACHE)

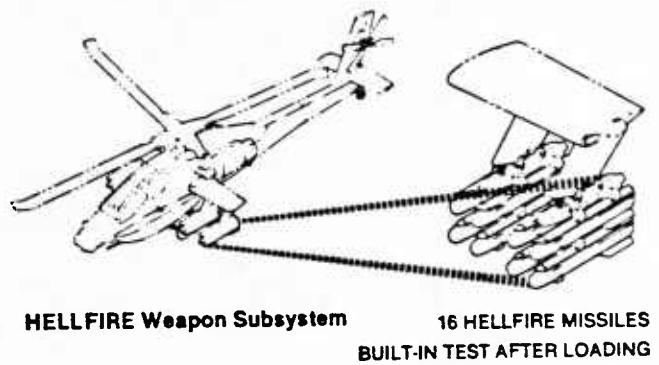
tion and navigation teamwork and to minimize weapon response time. The pilot is in the aft cockpit elevated above the copilot/gunner to maximize visibility from the rear location. The helicopter is powered by two 1600 HP General Electric T-700-GE-701 turboshaft engines. Mounted in each engine nacelle is an infrared suppressor system. The AAH main rotor is 48 feet in diameter, fully articulated with elastomeric lead-lag dampers. The blades incorporate -9° twist and operate at a tip speed of 726 fps. The antitorque rotor is 9.2 ft. in diameter. The blades are mounted on teetering hubs and are separated angularly at 55° (rather than 90°) for noise reduction. The AAH incorporates a stabilator mounted below the tail rotor. The helicopter has dual flight control systems, an automatic wing flap control to enhance maneuverability, and a redundant fly-by-wire backup control system. The armament sub-systems, Figure I-4, are comprised of a 30mm lightweight (chain gun) weapon mounted in a flexible turret on the underside of the forward fuselage, a 2.75 inch rocket system, and the HELLFIRE Modular Missile System (HMMS) point target weapon mounted on pods attached to the wing stations. The fire control system consists of the Target Acquisition Designation Sight (TADS) and the Pilot Night Vision Sensor (PNVS); two Integrated Helmet and Display Sight Subsystem (IHADSS); data system; fire control computer; and the necessary controls and displays required to fire the weapon. The avionics includes a Lightweight Doppler Navigational System (LDNS), an Identification Friend or Foe (IFF) transponder system, and a standard set of communication and secure voice equipment. A Fault Detection and Location System (FD/LS) provides a means to test subsystems and fault isolate to the Line Replaceable Unit (LRU) level.

The AAH has the following performance profile requirement under 4,000/95°F conditions with the primary mission pay load of eight HELLFIRE missiles, 320 rounds of 30mm ADEN/DEFA ammunition, and a crew of two:

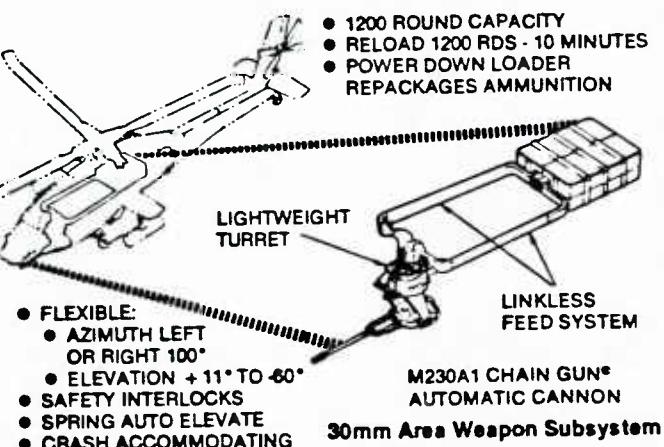
ARMAMENT INTEGRATION



POINT TARGET SUBSYSTEM



AREA WEAPON SUBSYSTEM



2.75 ROCKET SUBSYSTEM



Figure I-4

ARMAMENT SUBSYSTEMS

- o 450 feet/minute vertical rate of climb from a Hover Out of Ground Effect (HOGE) at 95% intermediate rated power.
- o 1.83 hours endurance
- o 145 Knots cruise air speed

The AAH is designed to be survivable to the impact of a 23mm round on the basic structure and main rotor blade. The dual flight controls are located so that no single 12.7 mm round can destroy both systems.

2. Organizational and Operational Concept

The mission of AAH units will be to provide direct or indirect fires as part of the overall scheme of the air/land battle as maneuver units of the combined arms teams. The capabilities of the AAH will be integrated into the tactical commander's scheme of fire and maneuver. The Attack Helicopter Company of the Attack Helicopter Battalion will normally be the lowest level at which attack helicopters will be task organized within the combined arms team. These companies are organic to the Army Division (armored, mechanized, airborne and air assault) and the armored cavalry regiments. Attack helicopter companies are organic to the Cavalry Brigade, Air Combat. Each company will have a total of 18 AH-64s.

The primary task of the attack helicopter company is to disrupt and destroy enemy armor/mechanized forces. When used in air cavalry operation the AH-64 will attack targets of opportunity located by the air cavalry and provide fire power and security for all elements of the cavalry. During air mobile operations, the AH-64 will provide aerial escort for troop carrying helicopters by providing protective fires as necessary.

3. Support

The AAH weapons system is designed around the Army's three levels of aviation maintenance: Aviation Unit Maintenance (AVUM), Aviation Intermediate Maintenance (AVIM), and Depot Maintenance. The unique AAH refueling and rearming capabilities provide for a "quick turnaround" at the Forward Area Replenishment Point (FARP). Replacement of parts is accomplished at the AVUM through the use of on-board fault detection and location systems, quick change components, and simplified trouble-shooting and maintenance publications. At the AVIM, the specialized Automatic Test Station is used to determine the defective part and to identify the repair procedures. Depot support in the first three years will be provided by the contractor. The AAH can operate and is capable of being deployed and supported on a worldwide basis.

II. PROGRAM STRATEGY

A. OVERALL PLAN

In September 1972, the U.S. Army approved an AAH development program. The AAH program was presented to the DSARC I, and on 10 November 1972, the DEPSECDEF authorized the release of RFPs for the AAH development. RFPs were issued on 15 November 1972. The RFP stressed acquisition and operational costs as prime considerations in the program and solicited technical proposals for the following alternatives.

Alternative A.

The fabrication of six (6) prototype helicopters (1 ground test and 5 flight vehicles). Under this alternative only one contractor was to be selected from the outset.

Alternative B.

This alternative program was separated into two phases. The first phase of engineering development would be awarded to two contractors. Each contractor would be required to fabricate one (1) ground test and two (2) flight vehicles. Following Government competitive testing and evaluation, one of the two contractors would be selected for the exercise of the option to manufacture three (3) additional AAH prototype aircraft and conduct total systems integration. A total of nine (9) vehicles would be fabricated under this alternative.

The RFP was written to allow the selection of either one contractor (Alternative A) or two contractors (Alternative B). The results of the eva-

luation of the contractor's proposals would provide the basis for deciding whether to proceed with a single contractor or to award development contracts to two contractors to build competitive prototypes. Five helicopter manufacturers; Bell, Sikorsky, Boeing Vertol, Hughes, and Lockheed responded to the RFP.

In June 1973, the DEPSECDEF authorized the Army to initiate a two-phased development of the Advanced Attack Helicopter (Alternative B). Phase 1 was a competitive development for selecting the best helicopter airframe to enter Phase 2, Full Scale Engineering Development (FSED). Phase 2 was to focus on completing subsystems (missile, cannon, rocket, target acquisition and night vision) development and their integration into the winning helicopter prototype airframe by the airframe contractor. On 22 June, Phase 1 competitive development contracts were awarded to Bell Helicopter Textron and Hughes Helicopter.

Figures II-1 thru II-3 reflect the major milestones established for development of the AAH and the planned and actual acquisition schedules. Although they are not included in the original AAH acquisition plan, the TADS/PNVS and HELLFIRE schedules are also shown.

B. ACQUISITION STRATEGY

1. General

Acquisition strategy is the conceptual basis for all planning for accomplishing specified goals and objectives to attain a mature and logically supportable weapon system or equipment. It gives an overview of management concepts and Program Manager (PM) actions planned to ensure satisfaction

<u>MILESTONES</u>	<u>TARGET DATE</u>
ASARC I	Sep 72
DSARC I	Sep 72
Engineering Development (Phase 1) Contract Award	Jun 73
ASARC II	Dec 76
DSARC II	Dec 76
Full Scale Engineering Development/Producibility Engineering and Planning Contract Award (Phase 2)	Dec 76
TADS/PNVS Contract Award (Competitive Development Phase)	Mar 77
TADS/PNVS Contract Award (Maturity Phase)	Apr 80
ASARC III	Nov 81
DSARC III	Mar 82
Initial Production Contract Awards	Apr 82

Figure II-1

ADVANCED ATTACK HELICOPTER PROGRAM MILESTONES

AAH

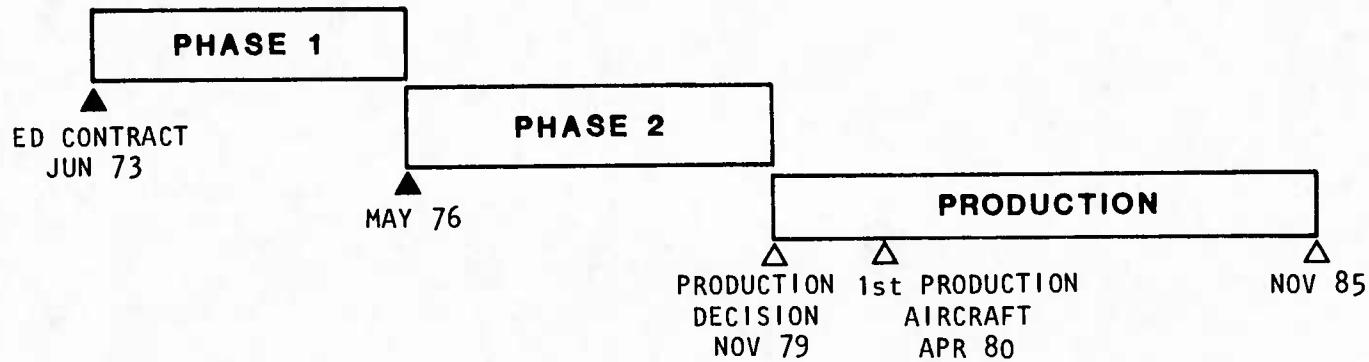


Figure 11-2

ADVANCED ATTACK HELICOPTER PLANNED ACQUISITION SCHEDULE-1972

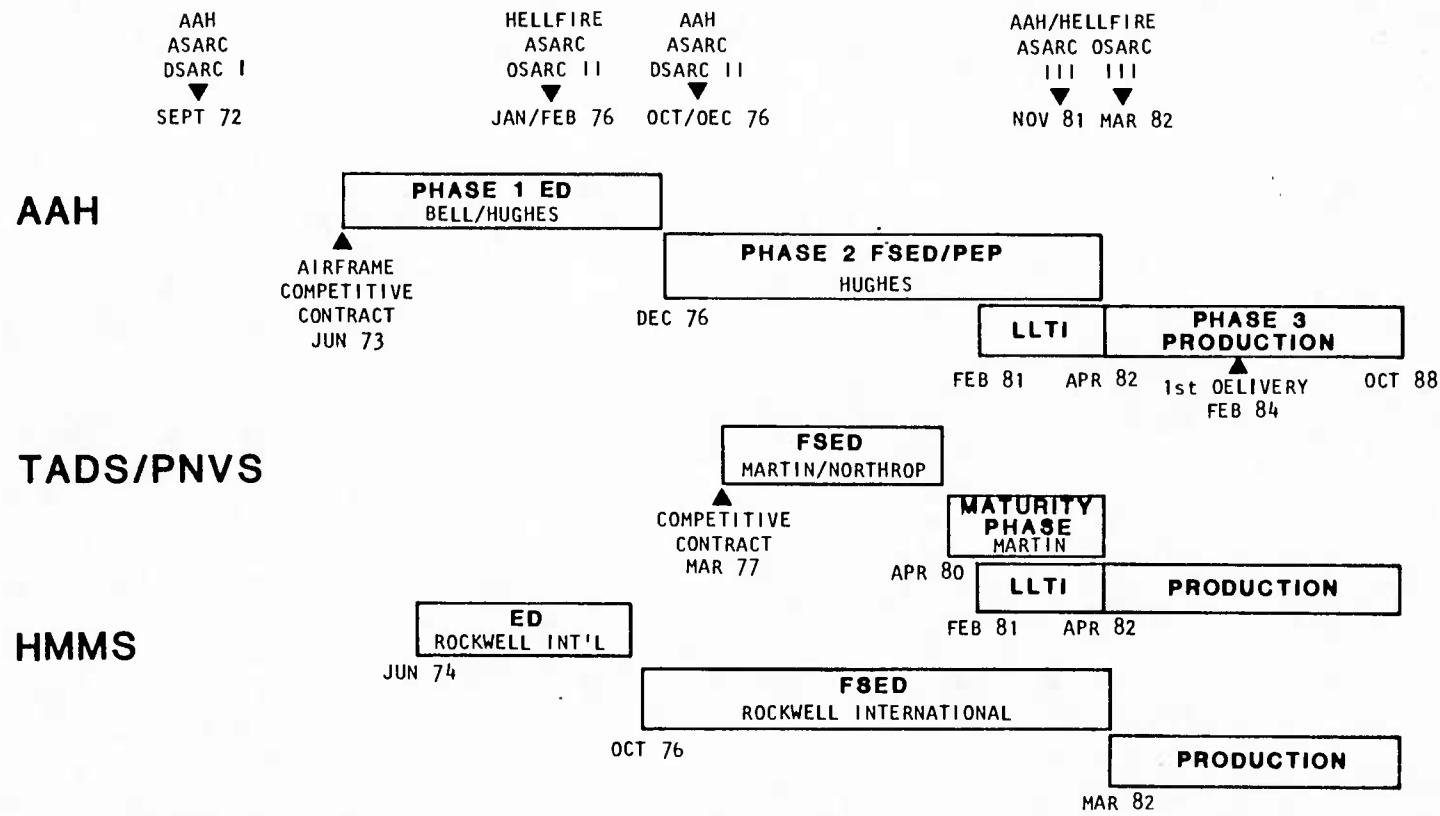


Figure 11-3

ADVANCED ATTACK HELICOPTER ACQUISITION SCHEDULE-1982

of the approved mission need. The acquisition strategy covers every phase of the development of a major weapon system, including operation and maintenance considerations. At any stage of the acquisition process, the strategy must address the remaining life of the program. "...because no two programs are exactly alike, each requires a tailored acquisition strategy..."¹

2. Advanced Attack Helicopter System

The AAH acquisition strategy reflected guidance concerning competition, accelerated development, an intensive design-to-cost effort, systems integration, and provisions for system growth.

a. Competition

Two prime contractors were selected in 1973 for the Phase 1 Competitive Engineering Development of two airframes. Development and fabrication of prototypes and scored testing were accomplished between the two competing contractors to facilitate selection of a single prime contractor for the Phase 2 FSED. Likewise, the TADS/PNVS subsystem was competed between two contractors during the Engineering Development Phase, with an AAH flyoff test to select a contractor to enter FSED with TADS/PNVS.

Contractual clauses for breakout and competitive procurement to the maximum practical extent were included in the production contracts with both Hughes Helicopters, Inc. for the airframes and Martin Marietta for TADS/PNVS. Contractual clauses giving the Government the right to require qualification of additional sources were included in these contracts. In January 1981 the

¹Guide for the Management of Joint Service Programs, DSMC, June 1982.

AAH PM established an AAH Component Breakout Team. This team identified several breakout candidates, i.e., the auxiliary power unit, armored crew seat, and main landing gear.

b. Accelerated Development

Although the AAH program was designated as "Top Priority" by DOD, the only concurrency of development/production was eliminated at the 20 June 1974 briefing to Assistant Secretary of the Army (R&D) due to lack of Aircraft Procurement Army (APA) funds.

c. Design-to-Cost (DTC) Effort

The DTC concept was rigorously applied during the Phase 1 Engineering Development. The Phase 2 FSED contract included a clause entitled, "DESIGN TO UNIT PRODUCTION COST (DTUPC) AND AWARD FEE." The DTC is covered in detail in Appendix D.

d. Systems Integration

The Phase 2 FSED contract for the AAH required the contractor to:

(1) Manufacture three additional AAH prototypes.

(2) Design and develop the mission subsystems (The HELLFIRE Modular Missile System [HMMS] was separately developed for integration into the AAH. The 2.75 inch rocket system was a Government Furnished Equipment (GFE). The TAD/PNVS was developed in a competition between Martin-Marietta and Northrop under contract to the Army and with associate contracts to Hughes Helicopters, the weapon system contractor and technical director. Subsequent to the competition, TADS/PNVS was GFE.

(3) Conduct systems integration of all subsystems into two of the Phase 2 prototypes and two of the Phase 1 prototypes.

(4) Accomplish Point Target System (HELLFIRE) integration and testing.

The design and development of the AAH airframe and systems for the most part have used state-of-the-art technology. Major areas where the AAH is advancing or applying the highest level of current technology are the TADS/PNVS, Integrated Helmet and Display Sight System (IHADSS), software, and system integration.

e. System Growth Potential

The AAH PMO is considering some long range P³I concepts including a missile launch detector, improved armament suits, Single Channel Ground and Airborne Radio System (SINCGARS), and incorporation of several advanced combined battle field electronic systems. These enhancements to the AAH will be incorporated into block improvement packages.

f. During the conduct of the AAH development, several events occurred which altered the AAH acquisition strategy.² These changes, which are listed below, are addressed in subsequent Appendices of this report.

(1) A six month extension of Phase 1 due to FY75 funding constraints.

(2) Descoping of work previously planned for Phase 1 and the shifting of this effort into Phase 2 to remain within FY76 - FY 7T budgetary limitations.

²Development Concept Paper No. 123B, 1 March 1982.

(3) The HELLFIRE DSARC decision to replace TOW with HELLFIRE on the AAH.

(4) The Advanced Scout Helicopter (ASH) DSARC decision to have the TADS/PNVS competitively developed and subsequent Congressional guidance that this effort be funded and managed by the AAH Program.

(5) The Congressional and DOD pressure to replace the WECOM 30MM ammunition with ADEN/DEFA interoperable 30mm ammunition (XM 788/789).

(6) A five month extension to Phase 2 to accommodate basic aerial vehicle design changes not originally contemplated, due to such deficiencies as tail boom loads, vibrations, and canopy drumming.

(7) A six month extension to Phase 2 due to FY78 budget reduction from \$200m and \$165m.

(8) An eleven month delay in Initial Operational Capability (IOC) caused by increasing industry-wide production lead time and redesign of the AAH empennage to incorporate a stabilator in lieu of the T-tail to resolve flight handling qualities problems with an attendant revision of the Phase 2 development program combining OT IIa and IIb into a single three month event.

III. PRINCIPAL LESSONS LEARNED

A. INTRODUCTION

This section presents a summary of the principal lessons learned from the study of the Advanced Attack Helicopter Program. The reader is referred to Appendices D thru H for the complete set of study team observations (lessons learned) and supporting background information.

B. BUSINESS MANAGEMENT

1. The Procurement Contracting Officer (PCO) should be assigned to the supporting major command, not to the PMO. This provides a procurement management check and balance on the PMO and makes the best use of required resources.

2. Recognize that a Design-to-Cost (DTC) program may not serve to discipline cost growth. However, its primary value may be derived from the visibility and continuous record of costs that it provides.

3. DTC programs provide a data base from which the contractor's production cost estimates can be evaluated and negotiated.

4. The use of an award fee incentive on the achievement of DTC should not be expected to make DTC work.

5. The TADS/PNVS Design-to-Cost Program has been relatively successful because both contractors had provided DTC data to the Government that were real--thus, enabling the government to obtain realistic prices because the goals were realistic. DTC was more successful in the Maturity Plan because of the government's experience from the competitive phase.

C. TECHNICAL MANAGEMENT

1. Competitive prototyping of the airframe only during Phase 1 was the less risky and less costly way to go. However, it did not provide the basis for evaluating the contractor's ability to manage the subsystem integration task.
2. Fabrication of prototype during engineering development (or advanced development) is necessary to support the decision to proceed to FSED and provide the hardware suitable for government testing.
3. The integration of complex subsystems by the prime contractor can be facilitated by the establishment of an Interface Control Working Group involving the PMO and the contractors and funding of contractor interface activities.
4. Consideration should be given to the establishment of a separate subsystem project office under the system Program Manager for critical subsystems such as TADS/PNVS in order that the required resources for government management of the project are available.

D. TEST AND EVALUATION MANAGEMENT

1. Execute memorandums of agreement among all test participants in order to avoid the different interpretations of the DoD and Army testing regulations that are possible.
2. Having PMO personnel at the test site can improve test continuity, facilitate the flow of spares and repair parts, monitor the contractor's performance, and provide the PM with timely status reports.

3. When equipment availability is limited and the schedule is constrained, DT-I and OT-I should be fully integrated wherever and whenever practical.

4. Positive actions are necessary to ensure that corrections to test reports are promptly provided to all of the original addressees. Use of an addendum to the original report is recommended.

5. Regardless of the amount of pre-test coordination achieved through the Test Integration Working Group (TIWG), Coordinated Test Plan (CTP), and in other ways, the PMO should realize that the operational tester will probably use a different system for RAM data collection than that used by the PMO. Funds will be required to convert the OT data to the on-going PMO system.

E. INTEGRATED LOGISTICS SUPPORT MANAGEMENT

1. Competitive Phase 1 costs can be reduced by placing maximum responsibility on the contractors for logistic support of their prototypes.

2. Phase 1 funds can also be saved by not requiring the competing contractors to train Army maintenance personnel.

3. RFP and proposal preparation and source selection evaluations require that the magnitude of the LSA effort be clearly stated by the Government and well understood by the contractors and subcontractors.

4. Current spares requirements should be based on the current expected failure rates not on the maturity rate which might not be reached for several years.

F. GENERAL OBSERVATIONS

The success of a weapons system acquisition program is as dependent upon overcoming the chaos of the Federal budgetary process, the degree of agreement obtained among the executive department, and the leadership of the PM as it is upon the hardware development program.

APPENDIX A

PROGRAM ORGANIZATION

1. Overall Organization for the Advanced Attack Helicopter.
2. The Advanced Attack Helicopter Program Office.
3. The HELLFIRE/Ground Laser Designator Project Office.

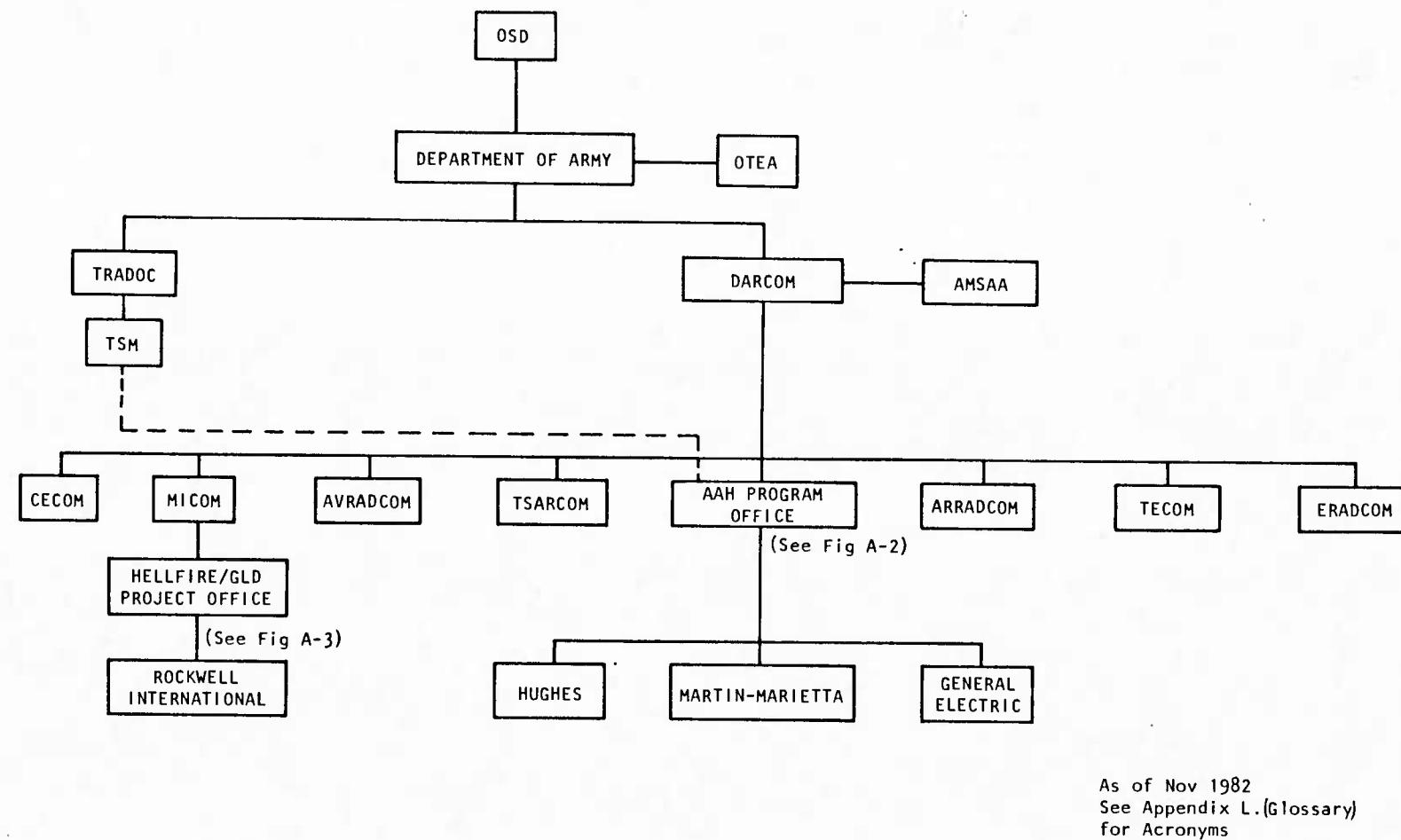
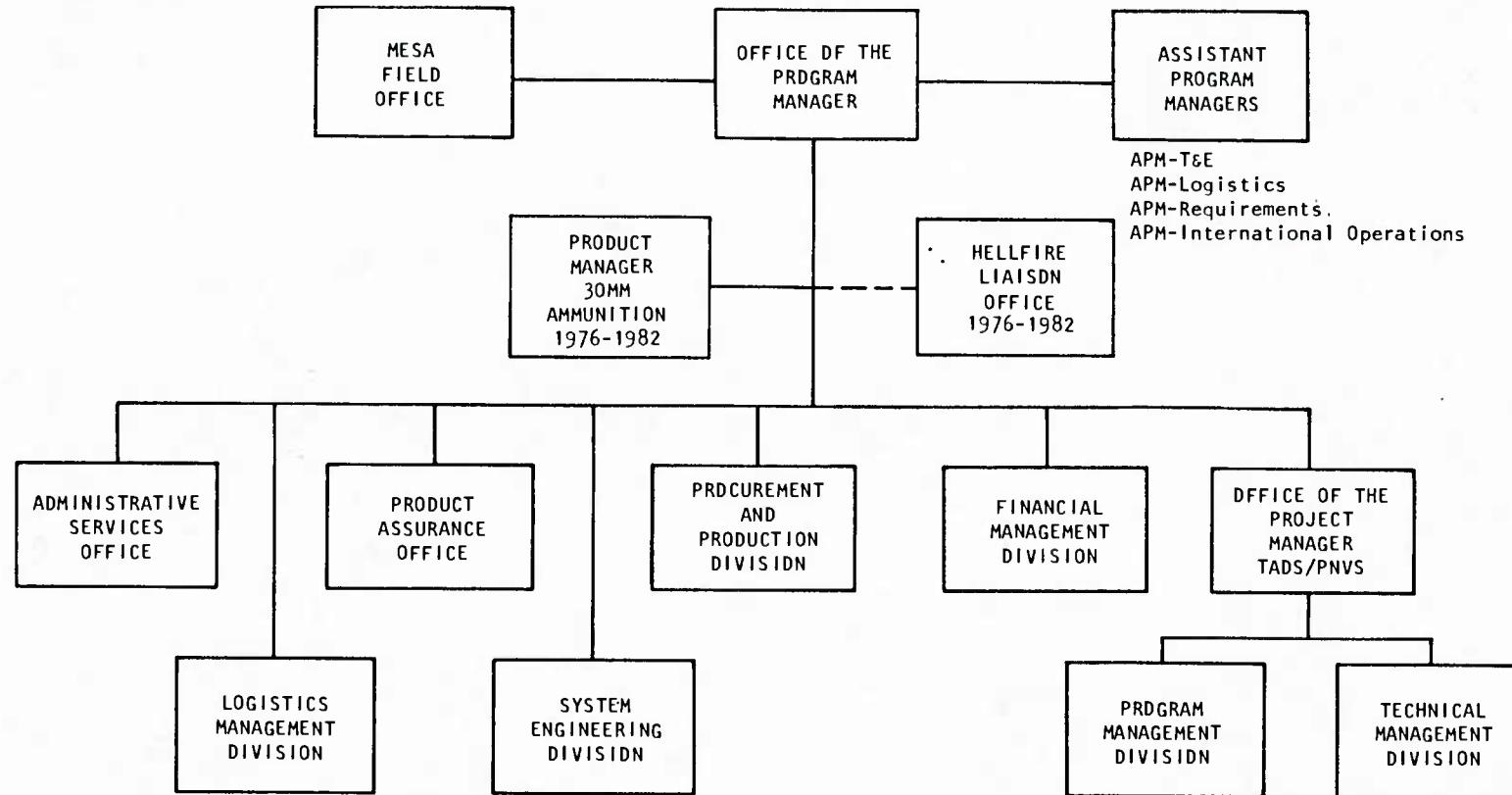
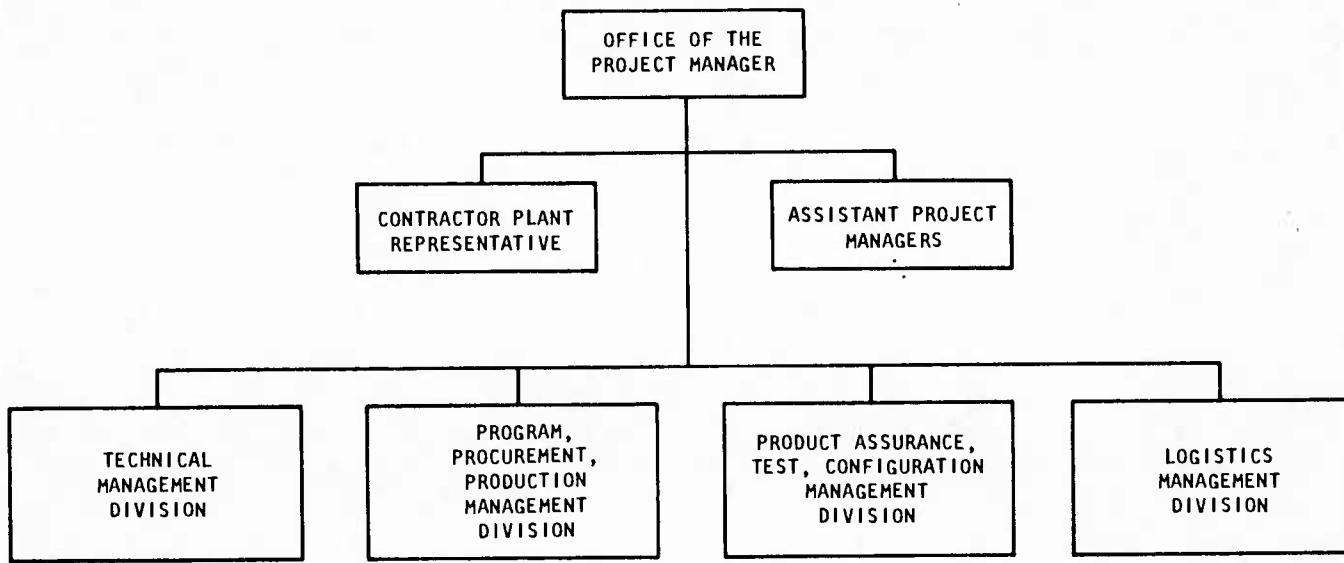


Figure A-1
OVERALL ORGANIZATION FOR THE ADVANCED ATTACK HELICOPTER



AS OF DEC 1982

Figure A-2
ORGANIZATION OF ADVANCED ATTACK HELICOPTER PROGRAM OFFICE



AS OF NOV 1982

Figure A-3
ORGANIZATION OF HELLFIRE/GROUND LASER DESIGNATOR PROJECT OFFICE

APPENDIX B

HISTORY OF THE AH-64A ADVANCED ATTACK HELICOPTER PROGRAM

1. 1965-71 PRINCIPAL EVENTS

In March 1966, the Army initiated a development program with the Lockheed Aircraft Corporation to design and develop an Advance Aerial Fire Support System (Cheyenne). The Cheyenne Attack Helicopter Program encountered technical problems, cost increases, questions regarding the Army's requirements for an attack helicopter, and competition from several company funded candidates (see Section I, Introduction, for more details).

2. 1972 PRINCIPAL EVENTS

a. In January, the AAH Task Force was established to make an indepth study of the operational requirements for an attack helicopter for the 1975-1985 timeframe.

b. On 7 August, the AAHTF delivered their report to the Army. The TF recommended a "new start" and provided an AAH Materiel Need (MN).

c. On 9 August, the Secretary of the Army terminated the Cheyenne program and established the AAH PMO with BG Bolz as PM.

d. In September the AAH MN was approved.

e. In September the ASARC I recommended a two phase AAH development program.

f. Also in September the ASARC recommendations were presented to DSARC I.

g. On 10 November the DEPSECDEF authorized release of the RFP. A \$1.4M \$1.6M \$FY72 constraint was placed on recurring flyaway DTUPC based on a 472 aircraft buy.

h. In December, the HELLFIRE MN was approved (Advanced Anti-Tank Missile Air to Ground).

3. 1973 PRINCIPAL EVENTS

a. On 13 March the AAH Advanced Procurement Plan (Alternative B) was approved by HQDA.

b. On 17 May the AAH DCP #123 was signed by the DEPSECDEF.

c. On 21 June the DepSecDef authorized the Army to initiate a two-phased engineering development program for the AAH.

d. On 22 June Phase I competitive contracts were awarded to Bell Helicopter Textron and Hughes Helicopters to design and fabricate a ground test vehicle and two flying prototypes.

e. On 19 July, the DEPSECDEF, by memorandum to the Secretary of the Army, directed the Army to use a most likely unit flyaway cost of \$1.8M in its SARs. The \$1.6M DTUPC goal was not changed.

4. 1974 PRINCIPAL EVENT

In June, the advanced development contract for HELLFIRE was awarded to Rockwell International.

5. 1975 PRINCIPAL EVENTS

a. In April, Procurement Plan No. 2 was prepared in order to accommodate a six (6)-month schedule slip.

b. On 25 September DCP Cover Sheet No. 2, which provided for the six (6) month extension of Phase I and, therefore, extended the completion date of Phase II, was forwarded to the OSD.

c. On 30 September, Hughes made the first flight of it's prototype attack helicopter.

d. On 1 October, a Bell prototype made it's first flight.

e. On 6 October the DEPSECDEF memorandum directed that the Armed Scout Helicopter (ASH) Program incorporate common mission equipment for multiple helicopter application/observation, scout, utility and attack.

6. 1976 PRINCIPAL EVENTS

a. On 6 January and 26 February, respectively, the HELLFIRE ASARC/DSARC II resulted in a decision that the HELLFIRE Program enter ED and that HELLFIRE be used on the AAH in lieu of the TOW missile.

b. In February, Congress approved Army's \$14.6M reprogramming request, due to Bell and Hughes costs problems.

c. On 23 March, at the ASH DSARC Ia, the TADS/PNVS project was directed to have a competitive development phase with a flyoff on the AAH during its Phase II FSED.

d. On 30 March, the DEPSECDEF approved HELLFIRE for entering FSED but required that the Army develop a plan for the overall coordination and management of AAH, ASH, HELLFIRE.

e. Also in April, Procurement Plan No. 3, which added TADS/PNVS and HELLFIRE was approved. The MN was changed to reflect the HELLFIRE decision.

f. During the period May through September, the HELLFIRE DT/OT I was conducted.

g. In May an LOI for the AAH FSED phase was released to Bell and Hughes, announcing the change from TOW to HELLFIRE.

h. Also in May, the contractors delivered prototype AAHs to the Government.

i. During the period July to September, the Bell and Hughes AAH proposals for FSED were evaluated.

j. On 29 September, the decision by DoD that AAH would use the ADEN/DEFA (BRITISH/FRENCH) classes of ammunition, paved the way for development of 30mm low impulse ammunition and U.S. support for further NATO standardization.

k. In September the PM AAH initiated the 30mm ammunition program with a Product Management Office at the Army Armament Research and Development Command (ARRADCOM), under the supervision of the AAH PMO.

l. In September the ASH Program was terminated.

m. In October ASARC II recommended that AAH proceed to FSED.

- n. In October the HELLFIRE FSED contract was awarded.
- o. In November, the TADS/PNVS proposals were received from seven (7) firms.
- p. On 10 December, the AAH source selection results were presented to the Secretary of the Army. Hughes was selected as the winner and following DSARC II the DEPSECDEF authorized the Army to proceed with the AAH FSED program.
- q. In December the contract for AAH FSED was awarded to Hughes.

7. 1977 PRINCIPAL EVENTS

- a. On 25 February, GAO released PSAD-77-32, Status of AAH Program.
- b. On 10 March, the TADS/PNVS competitive development contracts were awarded to Martin-Marietta and Northrop.
- c. Also in March, the TADS/PNVS project management office was established and assigned to the AAH PMO.

8. 1978 PRINCIPAL EVENTS

- a. During the period January to March, the Army conducted an Aviation RSI Review with emphasis on AAH and ASH systems to satisfy US/FR/GE requirements for an anti-tank helicopter.
- b. On 13 February, Procurement Plan No. 4 was prepared to incorporate the TADS/PNVS requirement for AAH.
- c. In May, both the House and Senate Armed Services Committees directed that the Army should investigate the feasibility of acquiring an existing

aircraft for the Army Helicopter Improvement Program (AHIP). The committees recommended addition of \$20.9m to accelerate development of AHIP to be consistent with the Army's fielding of the AAH.

d. In July, Congress added a requirement that the AHIP IOC would be NLT 31 December 1984.

e. In October the first AAH FSED model flight tests commenced.

f. Also in October, the HELLFIRE missile firing tests commenced.

9. 1979 PRINCIPAL EVENTS

a. In February, the Development Test Training Detachment was activated.

b. In July the AAH production contract award was delayed one year due to increasing production leadtimes and the restructuring of the OT plan to provide additional time prior to OT to correct technical problems.

c. On 31 July, the AAH Procurement Plan No. 5 was prepared in anticipation of production of the TADS/PNVS and its integration in the AAH.

d. In September, Martin Marietta and Northrop delivered their prototype TADS/PNVS to the Government.

e. In November, the ASARC, based on an August 1978 - August 1979 Study Group Analysis, concluded that the Army could not afford ASH. The OSD agreed with the Army position.

f. On 11 June GAO issued PSAD-79-65: Aerial Fire Support Weapons: How Useful Would They Be In a European Conflict?

g. Changeover in Hughes management occurred.

10. 1980 PRINCIPAL EVENTS

a. During the period January to March, the TADS/PNVS flyoff was completed by the Government.

b. In April, Martin Marietta was selected as the winner of the TADS/PNVS competition.

c. In April the TADS/PNVS Maturity Phase contract was awarded to Martin Marietta.

d. In July the ASARC was briefed regarding the aerial scout requirements, formerly the ASH. Decision was to develop and field an improved scout helicopter by competing two inventory aircraft (OH-6A and OH-58) with mast mounted sights.

e. In November, AAH prototype AV04 was lost in a mid-air collision. No AAH technical problems or malfunctions were involved.

11. 1981 PRINCIPAL EVENTS

a. In January the Long Lead Time Items (LLTI) contract was awarded to Martin Marietta for TADS/PNVS.

b. Also in January the AHIP RFP was released.

c. In February, the LLTI contract was awarded to Hughes for the AAH airframe.

d. On 12 February, GAO issued C-MASAD-81-1, Problems Affecting the Procurement and Operation of the Army's AH-64 Attack Helicopter and Associated Systems.

e. In April, the decision was made to use the more powerful T-700-GE-701 engine for AH-64 production.

f. In May, the LLTI contract was awarded to GE for the engine.

g. In May, Hughes selected the Mesa, AZ, production site for AAH.

h. During the period June to August, the AAH OT-II was conducted by OTEA at Fort Hunter Liggett, CA.

i. In August, PRRs were completed at Hughes and Martin Marietta.

j. In September, the AHIP FSED contract with 2-year production options was awarded to Bell.

k. In November, the AAH w/HELLFIRE ASARC III recommended production and Type Classification Standard.

l. On 31 December, the Development Test Training Detachment was deactivated.

12. 1982 PRINCIPAL EVENTS

a. In January, the Cost and Operational Effectiveness Analysis (COEA) confirmed the superiority and effectiveness of the AAH.

b. In March, the HELLFIRE production contract was awarded.

- c. In March, DSARC III recommended production of AAH.
- d. On 15 April the SECDEF approved the AAH for production of 446 aircraft (down from the 536 planned earlier). FY83 TADS/PNVS production funds (2nd year buy) were withheld pending TADS test results and the preparation of an initial readiness assessment.
- e. In April, initial production contracts were awarded to Hughes (airframe), GE (engine), and Martin Marietta (TADS/PNVS).
- f. In June, the AAH DT II was completed.
- g. In June, the PM-30mm ammunition was deprojectized-mission accomplished.
- h. In July, the TADS/PNVS readiness assessment requirements were satisfied.
- i. In August the TADS/PNVS maturity phase was completed.
- j. On 30 November, MG Edward M. Browne retired, after nearly seven years as PM.

APPENDIX C
PROGRAM REVIEWS AND REDIRECTIONS

This Appendix serves to summarize the external forces that have impacted the AAH Program since the termination of the Cheyenne Program in 1972. Readers who review the following descriptions of Army, DoD, and Congressional actions will have a better understanding of the lessons learned from the AAH Program.

The AAH program commenced with a DTUPC goal of \$1.4M to \$1.6M \$FY72 that was later changed to a \$1.8M unit flyaway cost (also in \$FY72).

1976 was a year of turbulence for the AAH Program. The events of 1976 impacted the program cost, schedule, organization, and management. Early in the year instructions were received to replace the TOW missile with the HELLFIRE Modular Missile System. Later the TADS/PNVS project was directed to have a competitive development phase and a flyoff on the AAH. Subsequently, the TADS/PNVS project team was transferred to the AAH PMO. Later in the year, the AAH PMO was instructed to use the ADEN/DEFA 30mm rounds for the area weapon subsystem rather than the planned WECOM 30 ammunition. In addition to the above events, the AAH Phase 1 competitive development ended, DT/OT I was conducted, and the winner selected for the Phase 2 program.

1. ARMY SYSTEMS ACQUISITION REVIEW COUNCIL

a. ASARC I, September 1972, recommended AAH development program be initiated.

b. ASARC II (HELLFIRE), January 1976, recommended missile enter FSED and be used on AAH.

c. ASARC Ia (ASH) March 1976, recommended TADS/PNVS system enter FSED and be used on AAH.

d. ASARC II, October 1976, recommended that AAH proceed to FSED with one contractor.

e. ASARC III, November 1981, AAH and HELLFIRE, recommended initial production of both systems.

2. OTHER ARMY ACTIONS

a. AAHTF established to study Army attack helicopter requirements - January 1972.

b. AAHTF Report recommends "new start" August 1972.

c. "New start" AAH effort authorized by Secretary of the Army, based on AAHTF MN - August 1972.

d. Cheyenne attack helicopter program terminated - August 1972.

e. Development of AHIP using inventory aircraft with mast mounted sight authorized - July 1976.

f. Armed Scout Helicopter (ASH) program terminated - September 1976.

g. ADEN/DEFA 30mm rounds selected for AAH area weapon subsystem - September 1976.

h. Army decision to use EQUATE (AN/USM-410) rather than going the "suitcase route" for automatic test equipment - 1980.

3. DEFENSE SYSTEMS ACQUISITION REVIEW COUNCIL

a. DSARC I, September 1972 recommended a two-phase engineering development program for AAH, SDDM signed 10 November 1972 authorized release of RFP and placed \$1.4 - \$1.6M (\$FY72) DTUPC constraint on program.

b. DSARC II (HELLFIRE), 26 February 1976, recommended that HELLFIRE proceed to FSED and that it replace TOW as the point target weapon on the AAH.

c. DSARC II (ASH-TADS/PNVS), 23 March 1976, directed that TADS/PNVS be competitively developed with a flyoff on the AAH in its Phase II. The SDDM was signed on 30 March 1976.

d. DSARC II.(AAH), 5 January 1977, recommended that the AAH program proceed into FSED.

e. DSARC III, March 1982, recommended limited production of the AAH with a procurement quantity of 446 aircraft. The SDDM was signed on 15 April 1982.

4. OTHER DOD REVIEWS/REDIRECTIONS

a. DEPSECDEF Memorandum to the Secretary of the Army, 21 June 1973, concurred with the Army's selection of contractors but expressed concern that the helicopter could be produced within the DTC range. Although the Army was authorized to announce the winners and to proceed to award the contracts, the contracts were to be modified to allow time for an Army/OSD Cost Analysis Improvement Group (CAIG) review of contractors' cost. This action delayed the start of development by over a month.

b. Assistant Secretary of Defense Memorandum of 1 March 1976, expressed concern with lack of integration of DOD reviews of HELLFIRE, AAH, and ASH. Directed Army to present formal AAH Program Review to the DSARC.

c. 29 March 1976 OSD Memorandum to the ASA (R&D) stated that Army should prepare to put the ADEN/DEFA 30mm round on the AAH in lieu of the planned WECOM 30.

d. 1976 - Army designated lead development service for 30mm ammunition.

e. 1977 - OSD reduced AAH funding by \$100M.

f. USDRE waives requirement for HELLFIRE DSARC II - 1982.

5. CONGRESSIONAL REVIEWS/REDIRECTIONS

a. May 1976 - Congressional review of ASH Program logic resulted in an amendment of the TADS/PNVS development plan. TADS/PNVS was to be developed competitively and total responsibility placed with the AAH Program. Funds transferred to AAH from ASH Program.

b. 1976 - Joint Congressional Conference Report (H.R. 12438) contained restrictive language stating that the Army could not use funds for the AAH 30mm gun until the Sec Army had selected the ammunition and notified Congress.

c. September 1976 - Joint H/SAC deleted all funds for ASH.

d. 1977 - \$65M restored to AAH Program.

e. 1978 - Combined House and Senate Armed Services Committees recommended addition of \$20.9M to accelerate development of AHIP to be consistent with Army's fielding of AAH. Directed that Army should investigate feasibility of acquiring an existing aircraft for AHIP.

APPENDIX D

BUSINESS MANAGEMENT

1. PROCUREMENT

a. Background

(1) In June 1973, the Deputy Secretary of Defense authorized the Army to initiate a two-phase development of the Advanced Attack Helicopter. Phase 1 was a competitive development of two airframes culminating with selection of the best helicopter airframe to enter Phase 2, Full Scale Engineering Development. Phase 2 focused on completing subsystems (missile, cannon, rocket, target acquisition and night vision) development and their integration into the winning helicopter. During June 1973, Bell Helicopter Company and Hughes Helicopters were awarded contracts to design and fabricate a static test article, a ground test vehicle and two flying prototypes to be evaluated in a competitive fly-off.

(2) Following first flight of the prototypes in September 1975, both companies conducted extensive development tests of their aircraft before delivering them to the Army for Government Competitive Tests at Edwards Air Force Base, California. The Source Selection results were presented to the Secretary of the Army in early December 1976. The Hughes YAH-64 was selected as the winner and a contract for the Phase 2 effort was awarded on 10 December 1976.

(3) Competing contractors, Martin Marietta Corporation and Northrop Corporation were formally selected and awarded contracts for the competitive development of TADS/PNVS on 10 Mar 77. Formal source selection following a

competitive fly-off on the YAH-64 resulted in the selection of Martin Marietta Corporation on 9 April 1980.

(4) The PMO planned to have the TADS/PNVS competing contractors to be directed subcontractors to Hughes Helicopter. However, at the time, the TADS/PNVS was considered to have potential application in other Army systems and there were legal considerations concerning Hughes Helicopter subcontracting to Hughes Aircraft, should Hughes Aircraft win the TADS/PNVS contract. Therefore, an unusual arrangement was established whereby the TADS/PNVS contractors (Martin-Marretta and Northrop) were made prime contractors to the government and subordinate to Hughes Helicopters (the system integration manager). The TADS/PNVS contractors were designate as associate contractors to Hughes.

b. Observations

(1) The Procurement Contracting Officer (PCO) for the AAH is assigned to AVRADCOM. This provides a procurement management check and balance on the PMO which could be strained if the PCO was assigned to the PMO. Since the PCO requires a complete supporting staff or must still rely on the command, any advantages in having a captive PCO would be offset by the resources which would have to be drawn from other functional areas in the PMO to support the PCO.

(2) If an associate contractor arrangement such as was done with the TADS/PNVS and AAH, is established, the Major system PMO should prepare for more frequent and more detailed involvement with contractor problems than would normally be experienced with prime/subcontractor relationships. Also,

if a competitive environment exists, the government (PMO) must be constantly aware of the requirement for fair and equal treatment while involved within the prime/associate contractors relationships.

(3) When a major component such as the TADS/PNVS is part of a major system such as the AAH, the procedure employed by the PM AAH should be considered. The decision to have a PM for the component should be based on the expected program cost, complexity of the component, and type of technology involved. The PM would require only a technical and program management staff since all other support could be provided by the weapon system PMO.

2. COMPETITION AND SOURCE SELECTION

a. Background

(1) A "fly-off" type development was used on the AAH and the TADS/PNVS (AAH for cost, TADS/PNVS for technical risk). This allowed a more competitive environment as well as providing a choice between two systems based on their technical merits. It is generally agreed that the AAH benefited technically through the use of competition. However, it is alleged to have added 36 months to the program and cost in excess of \$90M by including competition in the first phase. The presence of competition was also helpful in negotiating the AAH Phase 2 development contract and the TADS/PNVS Maturity Phase.

(2) Five contractors submitted proposals for the Phase 1 competitive effort to develop the AAH airframe. All offerors submitted viable proposals which were evaluated from a cost and technical standpoint. Two of the offerors, Boeing-Vertol and Sikorsky, were also competing primes for the con-

current UTTAS development. The third offeror, Lockheed, had recently had it's Cheyenne program terminated as the Army's AAFFS. Bell Helicopter Company and Hughes Helicopter were selected for the competitive Phase 1 effort.

b. Observations

(1) Staffing the AAH source selection evaluation board required the support of other commands. The requests for personnel were generally ignored until the PMO entered into active negotiations with the required individuals and their supervisors. Personnel support for Source Selection Evaluation Board (SSEB) is not automatic; the PMO and the command responsible for selection should be prepared for a time consuming effort to obtain the quantity and quality of personnel desired.

(2) Security requirements for protecting the competitors' proposals and the evaluation plan throughout the evaluation must be enforced. The need to protect the integrity of the evaluation process is a primary objective of the SSEB security plan.

(3) A resident SSEB member(s) should be knowledgable in the operation of any risk analysis program (model) used. The use of a formal procedural model assists in arriving at an organized and logical assessment of risk while constraining the degree of subjectiveness introduced.

(4) Subjects for fact finding or negotiation were provided to the contractors in sufficient time to allow them to prepare for their discussion. All fact finding questions were reviewed by the Deputy Chairman, the Area Chief, and selected evaluators to assure their appropriateness and clarity prior to being released to the contractor.

(5) DARCOM R 715-3, Proposal Evaluation and Source Selection, Oct 80 is now available to assist in the planning and conduct of a source selection.

(6) The Government should make every effort to treat all competitors fairly. However, it will be impossible to treat them equally. Differences such as the level of funding negotiated on their individual contracts will preclude the latter. The best interests of the program should promote the former.

(7) It is questionable that the total savings for the AAH will be commensurate with the additional development costs. In addition, whenever a program is extended, the number of decision points increases and each decision is an opportunity for the challenge of possible program cutbacks or elimination.

(8) Cost contracts in competition weaken (at least) the effectiveness and objectives of competition. Both sets of competition (Bell/Hughes) and (Martin-Marietta/Northrop) saw large disparities between their estimated costs to completion. Both also received more funds than initially estimated by either the contractor or the government.

4. COST MANAGEMENT

a. Background

The AAH Program has had design-to-cost (DTC) tracking from its outset. The original goal of \$1.4 to \$1.6M recurring cost per aircraft was based on the production cost for the A-10 airframe, an AF aircraft with a mission similar to the AAH (tank killer). OSD's rational was that there was no requirement for a second tank killer if it costs more than an existing weapon system.

The unit DTC goal in FY 72 constant dollars was set at \$1.6 recurring and \$.104M nonrecurring for a total of \$1.704M on a procurement of 472 aircraft. With additions to the DTC goal to reflect definitive changes in DODI 5000.33 for flyaway costs; the impact of changes in mission equipment to include the HELLFIRE missile and TADS/PNVS; adoption of the ADEN/DEFA 30mm round; changes in Government furnished equipment and changes in other system's programs, i.e. BLACKHAWK; the DTC goal had grown to \$2.251M (FY72\$) by FY81. More startling was the effect of escalation over the same period. Economic costs raised the AAH unit cost by \$5.020M to a total of \$7.271 M.

Figure D-1 shows the DTC growth since DSARC I in September 1972. Figure D-2 provides a more detailed explanation of the components of the DTC flyaway estimate in FY81.

b. Observations

(1) The primary value of the DTC program has proven to be the visibility and continuous record of costs it provides. DTC has not served to discipline cost growth, especially for nonrecurring tooling, engineering and

<u>FY72\$ Millions</u>		
ORIGINAL GOAL:	RECURRING NON-RECURRING MANAGEMENT RESERVE	\$1.600 .104 .100
		<u>\$1.804</u>
CHANGES:	HELLFIRE/TADS/PNVS NATO-INTEROPERABLE 30MM QUANTITY CHANGE (472 from 536) COST ACCOUNTING STANDARDS DEFINITIONAL CHANGES (PM/ECP) ENGINE IMPACT	.069 .009 (.046) .019 .156 <u>.088</u>
CURRENT	DESIGN-TO-COST GOAL (MAR 81 SAR) ENGINE GROWTH T701 ENGINE IMPACT	\$2.099 .140 <u>.012</u>
CURRENT	DESIGN-TO-COST ESTIMATE	\$2.251

Figure D-1

DESIGN TO COST GROWTH

	DSARC I SEP 72	DSARC II DEC 76	BASELINE COST ESTIMATES			REMARKS
			1978	1980	1981	
AIRFRAME	.800	.825	.847	.938	.938	80 BCE Shows Material Impact
MISSION	.635	.611	.616	.619	.619	
ENGINE	.165	.164	.205	.247	.397	Driven by UH-60 Cuts, Material Costs
RECURRING	1.600	1.600	1.668	1.804	1.954	
NON-RECURRING	.104	.104	.078	.097	.099	
MGT RESERVE	.100	.100	.103	.054	.054	
TOTAL	1.804	1.804	1.849	1.955	2.107	
SYS PROJ MGT			.080	.061	.061	Added to Flyaway by DODD 5000.33
ENG CHANGES			.078	.083	.083	
FLYAWAY			2.007	2.099	2.251	

AAH UNIT COST \$2.251M [FY72] + \$5.020M [ESCALATION] = \$7.271M

Figure D-2

DESIGN-TO-COST FLYAWAY ESTIMATE

program management service costs. It does provide the means to identify specific elements of cost growth.

(2) Despite DTC, the "real" unit cost is not seen until a production proposal is received. At that point, the proposal will bear little relationship to the DTC goals set during the development phase. The prime contractor is at the point where he must start to recognize some return on the investment (losses) made during a lengthy development. The production values will be predicated on the firm's business objectives more so than the DTC's goals. The AAH PMO, feeling the program was tracking fairly close to the DTC goal, was as shocked by Hughes' production proposal costs as was the rest of DA. Hughes had made several management personnel changes during the proposal preparation period and the new management had been directed to make a profit on the AAH program. The PMO was able to counter the new management's conservative approach to the perceived risks of moving into a new production facility through the use of detailed DTC recurring cost data.

(3) DTC provides a data base to evaluate and negotiate the contractor's production cost estimates. The data should be used to establish the government's "business position" to the lowest reasonable cost.

(4) The AAH PMO did not and could not fully execute the DTC program. The restraints of a manpower limited office in a program with heavy subcontractor involvement (estimated at 60% of program effort) precluded the conduct of the indepth analysis required.

(5) The use of an award fee incentive on the achievement of DTC should not be expected to make DTC work. Neither Bell nor Hughes was awarded

any of the award fees available for DTC issues in the first phase of the development. Hughes recognized by the second year of Phase II that it would never achieve the DTC goal and its award fee for all practical purposes was forfeit. Consequently, DTC was given lip service. Since Hughes was awarded the Phase 2 contract primarily on the basis of the technical merits of its aircraft despite known weaknesses in its management, the fact that it did not receive any of the fee for DTC is not surprising nor is it surprising that the AAH has proven to be more expensive than planned.

(6) One method the AAH program is using to control future costs is through a special provision in the development contract for TADS/PNVS.¹ Options for production years one and two were negotiated prior to selection of the winner of the competitive development. Martin Marietta Corporation, the winner, agreed to target recurring hardware prices for production years three through seven. The target prices include direct costs, overhead, G&A expense, escalation, and profits based on a total TADS and PNVS production quantity of 542 each. The only price adjustments allowed, beyond those allowed by other contract clauses, are adjustments due to changes in quantity, changes which affect the required delivery schedule or production rate, Class I ECPs, or the results of abnormal fluctuations in the economy.

¹A formula adjustment to the current production contract price is made on the basis of the negotiated price for the next production contract. If the negotiated recurring costs are less than those set forth in the provision, thirty percent of the difference to a maximum increase of ten million dollars for each production year, will be added to the firm target price and ceiling price for the current production contracts. Should the negotiated price be higher than the scheduled price, the current production price will be decreased by the same formula. This methodology will be used for each production year through the seventh year.

(7) The TADS/PNVS DTC program has been relatively successful from its inception. Both competitors agreed to DTC goals that were as much as a third less than the Army's objective. Both contractors also paid attention to their DTC goals during their respective contractual performance. Although the actual DTC was greater than the contract goal it was still less than the Army's objective. Contributing to the achievement of DTC were the use of competition for subcontracted parts to get reasonable prices, use of proven common night vision modules, and extensive use of automatic test equipment in production.

(8) Lessons learned during the AH-64A Should Cost Analysis (SCA) include:

(a) The quality of contractor support is a function of the firm's management (both style and skill), and the firms' experience with Government procurement and should cost studies.

(b) Especially in the case of a contractor with limited Government experience, the Government should take the opportunity to discuss the details of a complex RFP to be sure the contractor understands what is expected in the proposal and its documentation.

(c) The Government's administration of the SCA should include a policy defining the organizations responsible for maintaining the various data bases and documents, and the proper methods of transmitting changes.

(d) Functional area chiefs/team leaders should seek input from "experts" in counterpart organizations, i.e. other PMOs, during proposal evaluation and fact finding. These individuals may have SCA experience on similar systems which could benefit the ongoing effort.

(e) If possible a cost specialist should be assigned to each technical area. In addition, each technical evaluator should be given adequate training to ensure that the basic cost terminology and the relationship of the cost elements are understood.

(9) Contingency funds or management reserves must be protected, even hidden, to assure their availability. If their use is not limited to true requirements, they will not be available when needed and may even be withdrawn if their use appears to be indiscriminate.

APPENDIX E
TECHNICAL MANAGEMENT

1. BACKGROUND

The AAH R&D program was a two-phased Engineering Development (ED) that took advantage of the technology and lessons learned from the Cheyenne program.

a. Phase 1 - Competitive Engineering Development (36 months)

On 15 November 1972 the Army released the AAH RFP to industry. The performance capabilities contained in the RFP are shown in Figure E-1. The AAH RFP allowed contractors to choose any engine that would enable the aircraft to achieve the required performance capabilities.

PERFORMANCE (PRIMARY MISSION)

Hover Out of Ground Effect	4000'/95°F
Vertical Rate of Climb	450 fpm
Airspeed - Cruise	145 knots
Lateral Acceleration	0.25/0.35g to 35 knots
Endurance (Mission Scenario)	1.9 hr
Ordnance (8 TOW, 800 RDS 30mm)	1,300 lb

EQUIPMENT

Passive IR Protection	2.75" FFAR
Gunners IR Night Vision	Loran Navigation
30mm Cannon	Fire Control Computer
TOW Missile	Avionics
Laser Rangefinder	Two Engines

Figure E-1

AAH CHARACTERISTICS--1972 RFP

Source: U.S. Senate, Committee on Armed Services, FY74 Authorizations for Military Procurement, Hearings, 93d Cong., 1st Session, Part 7, p. 4781.

In fact, both winning contractors selected the T-700-GE-700 engine, then being developed for the Army UTTAS helicopter. The engine was well along in development and promised to give the performance necessary to meet the Army's power requirements for the AAH.

The RFP requested that the bidding contractors submit two separate proposals.

(1) A sole-source development proposal that the service could select should one contractor's bid look clearly superior to all others.

(2) A proposal for competitive development of the airframe, engine, and 30mm gun combination, to be followed by a sole-source second phase during which the major subsystems (point target weapon, aerial weapon, fire control) would be integrated into the airframe. Pressures from OSD and the Army for competition made the selection of alternative one highly unlikely. The AAH RFP had the usual 90-day response limit, and by 15 February 1973, the Army had received 6 proposals from five firms. Lockheed submitted two proposals with designs similar to the Cheyenne; Sikorsky and Boeing Vertol proposals based their design on the UTTAS prototypes; Bell Helicopters, Textron and Hughes Helicopters, Inc.,¹ each submitted one proposal. In June the Army awarded Phase 1 contracts to Bell and Hughes.

An attempt was made to give the competing contractors flexibility in the development process by substituting ranges or bands of acceptable performance for point performance targets. The minimum performance goals or "floor" parameters are shown in Figure E-2. Use of the "J13 Clause" allowed each

¹Hughes Helicopter Division of Summa Corporation became Hughes Helicopters, Inc., a wholly owned subsidiary of Summa Corporation, 1 January 1981.

Speed	145 Knots
Rate of Climb	450 fpm at 4000 ft and 95°F
Fire Power	8 TOWS, 800 Rds 30mm ammunition
Endurance	1.9 hrs.

* Listed in Priority

**Figure E-2
AAH MINIMUM ESSENTIAL PERFORMANCE
GOALS "FLOOR PARAMETERS"**

contractor to make design tradeoffs in the areas above the "floors" without Army approval on a priority basis and allowed the contractors to suggest changes to the floor parameters if such change would result in significant cost savings. However, this led to problems because the contractors had made trade-offs that later had to be reconsidered.

During the Phase 1 prototype development, each contractor approached the managerial and technical aspects differently. The Bell Helicopter candidate (YAH-63) was designed and built in house using the contractor's plant capacity and years of experience. The YAH-63 was a two-bladed, tri-cycle-gear aircraft, with the pilot located in the forward seat. The 30mm gun was in the nose of the helicopter with the FLIR and visionics equipment just behind and beneath it.

In contrast, Hughes lacked the in-house capacity to build a medium helicopter like the AAH and, therefore, used the team approach to develop their prototype, the YAH-64. Figure E-3 is a list of the twelve contractors comprising the Hughes team. Hughes designed and assembled the aircraft using components built by the team members, who also served as design consultants.

Although this approach was more costly than an in-house effort, Hughes was able to capture the expertise and experience of long-standing design firms. The YAH-64 was a four-bladed, 3 point-gear system with the pilot in the rear, positioned 19 inches above the copilot. Hughes designers located the 30mm gun beneath the gunner and the forward looking infrared and visionics equipment in the "chin bubble". The Hughes rationale for this reversal of gun/visionics location was survivability of the very expensive sighting equipment in the event of a crash landing.

Bendix Corporation's Electric-Fluid Power Division: Design and fabrication of drive shafts, couplings, and electrical power systems.
Bertea Corporation: Hydraulic control systems.
Garrett Corporation: Design and fabrication of infrared suppression and integrated pressurized air systems.
Hi-Shear Corporation: Manufacture of the canopy and crew escape system.
Litton Precision Gear Division: Main transmission and engine nose gear boxes.
Menasco Manufacturing, Incorporated: Landing gear units.
Solar Division of International Harvester Corporation: Production of APU.
Sperry Flight Systems Division: Manufacture of automatic stabilization equipment.
Teledyne Ryan Aeronautical Division: Airframe structure fabrication.
Teledyne Systems: Fire control computer.
Tool Research and Engineering Corporation: Main and tail rotor blades.
Western Gear: Intermediate and tail rotor gear boxes.

Figure E-3

HUGHES HELICOPTER DEVELOPMENT TEAM - 1973

Following extensive contractor tests, both Bell and Hughes delivered their prototypes to the Army for competitive tests at Edwards Air Force Base, California. The evaluation involved a set of criteria applicable to technical, operational suitability, cost management, and logistics areas. The

YAH-64 was superior in the technical and operational suitability areas and met or exceeded requirements in all areas. Based on these results, Hughes was selected to enter Phase 2 in December 1976.

b. Phase 2 - Full-Scale Engineering Development (50 months).

Originally, the Army had planned that Phase 2 of the AAH program would be a 30-month, sole-source FSD effort to integrate the TOW system and other subsystems to the winning airframe selected from the Phase 1 competition. However, by the end of Phase 1, development costs had nearly doubled and the schedule for Phase 1 had been slipped 6 months. These cost and schedule changes resulted primarily from changes in AAH requirements, Congressional funding actions, and a pre-DSARC re-appraisal of the overall program cost and schedule.

In 1975 Congress refused to fund the purchase of Prototype Development Lead Time Items (PDLTI) for Phase 2 because Congress felt that one set of PDLTI would be wasted once a winner was selected. This action subsequently delayed the fabrication of three additional YAH-64s by five months at a cost in FY81 dollars of \$25.1 million.

In February 1976 at the ASARC for HELLFIRE, the Army decided to replace the TOW system on the AAH with the HELLFIRE anti-tank missile. This decision was endorsed by the DSARC in April 1976. The decision also required replacement of the TOW visual sighting system with the more technically complex and capable sighting system called the Target Acquisition Designation Sight/Pilot's Night Vision Sensor (TADS/PNVS). Because both Bell and Hughes were well into Phase 1 of the AAH development, the Army decided not to rewrite the

AAH RFP, but rather to send each contractor a Letter of Instruction (LOI) indicating that proposals for Phase 2 development should be based on the HELLFIRE Missile System rather than TOW.

The effects on the AAH program were immediate. Not only were costs and schedules impacted, but the change to HELLFIRE added 400 pounds to the flyaway weight of the fully armed AAH. The Army compensated for the increase in weight by decreasing the number of 30mm rounds in the basic load from 800 to 500.

The decision to incorporate the TADS/PNVS on the AAH added \$215.3 million (FY81 dollars) to the overall AAH development cost. This increase in cost covered the development of TADS/PNVS and integration of the system into the airframe. In September 1976, \$8.8 million more was added to account for the addition of direct-view optics to the TADS/PNVS package.

Another change in requirements for the AAH was made when OSD directed the Army to replace the Weapons Command (WECOM) 30mm cartridge with a cartridge usable in the ADEN and DEFA 30mm guns by NATO members. Although this change resulted in only minor adjustments to the original AAH requirement, the ADEN/DEFA decision increased the weight of the 500 rounds on-board the AAH. Therefore, the Army made a second reduction in the number of 30mm rounds - from 500 to 320 -- to compensate for the additional weight of the ADEN/DFEA rounds.

Because the AAH program had undergone numerous changes which resulted in making it dependent upon concurrent successful development of the HELLFIRE missile, TADS/PNVS, and the ADEN/DFEA ammunition, the Army conducted a full

review of the program's cost and schedule in preparation for DSARC II. This review resulted in adding 5 months to the Phase 2 schedule and changing the baseline cost estimate. Figure E-4 shows the cost and schedule changes made during Phase 1. In January 1977 the DSARC recommended that the AAH program

<u>PROGRAM CHANGE</u>	<u>DATE</u>	<u>SCHEDULE (MONTHS)</u>	<u>COST GROWTH FY72\$</u>
Baseline Estimate	1974	67	345.1
Changes			
Prototype cost growth	1975-76	6	42.7
Deletion of PDLTI	6/75	5	12.8
HELLFIRE Addition	2/76	5	43.0
TADS/PNVS	3/76	4	109.8
Direct View Optics	9/76	-	4.5
ADEN/DEFA ..	9/76	-	1.3
Baseline Cost Update	9/76	-	23.4
5-Month Phase Extension	10/76	5	39.2
DSARC Deliberations	12/76	-	-12.4
New Estimate		92	609.4

Figure E-4

PHASE 1 PROGRAM COST/SCHEDULE CHANGES

Source: RAND Report, The Use of Prototypes in Weapon System Development.
March 1981, p.175.

proceed into FSED. An OSD cut of \$100m in the FY78 AAH program budget following DSARC II forced the program office to negotiate a 60 month Phase 2 contract with Hughes. Subsequent action by Congress restored \$65 million of the OSD reduction. The resulting rescheduled program was for a 56 month FSED, Phase 2.

In addition to modifying the two Phase 1 prototypes and building three additional AAH prototypes to the latest configuration, the FSED contract included the requirements for total subsystem integration and a substantial Producibility Engineering and Planning (PEP) effort. The purpose of PEP is to ensure the economic producibility of the AAH and to plan for facilities, equipment, human resources training of the labor force, and sub-contractor and vendor selection. Therefore, PEP became an integral part of the engineering design effort. Manufacturing specialists worked in conjunction with design engineers to optimize the production design, i.e., selection of the proper materials and processes to achieve required levels of aircraft performance within availability and affordability of materials.

Concurrent with the design review effort, selection of the most cost effective manufacturing process was considered as it related to the manufacturing state-of-the-art. Hughes made a sizable capital investment in machine tooling and equipment and built a 581,200 square foot manufacturing facility at Mesa, Arizona. The primary benefits of the Mesa location to the AAH program are labor availability, reduced risks in meeting schedules, and lower production costs. The cost to the government for this facilitization was zero.

In addition to PEP, Manufacturing Methods and Technology (MM&T) efforts were conducted aimed at reducing cost and improving loss reliability manufacturing processes. Examples of the MM&T effort include forming and joining methods, tooling concepts for non-metallic structures, and advanced composites manufacturing techniques.

c. Management Approach - Phase 2

Initially in the AAH Phase 2 FSED Program, the Program Manager's approach was a balanced mixture of management by exception and management by objective. Detailed Program Reviews (PRs) were conducted monthly with Hughes and Martin Marietta with agenda items being established based upon schedule and cost variances contained in the Cost/Schedule Control System Criteria (C/SCSC) performance measurement baseline. Intensive management emphasis was applied to those elements containing unfavorable indications. This approach was successful and furnished sufficient visibility to establish program status during the contractor testing in Phase 2. In August 1980, at the end of contractor testing and the beginning of Government testing, the management approach of the Program Manager shifted to one of intensive management of every element of the contractors program as well as to the requirements to successfully meet the DSARC requirements.² Five working group management teams were formed with membership from across the Army community to assure representation from all agencies involved, see Figures E-5 and E-6. A total of 76 milestone events were identified and successful completion of these milestones became the responsibility of the appropriate management team. The Program Manager conducted indepth biweekly reviews at which each team reported their progress.

The technical management of the AAH Phase 2 was primarily associated with the total aircraft development, to include mission essential subsystems and the Airworthiness Qualification Program, which ensured that the AAH could be safely operated and meet the "user's needs." The technical management effort

²AAH PM's Management Plan to DSARC III-and Beyond, August 1980 (C).

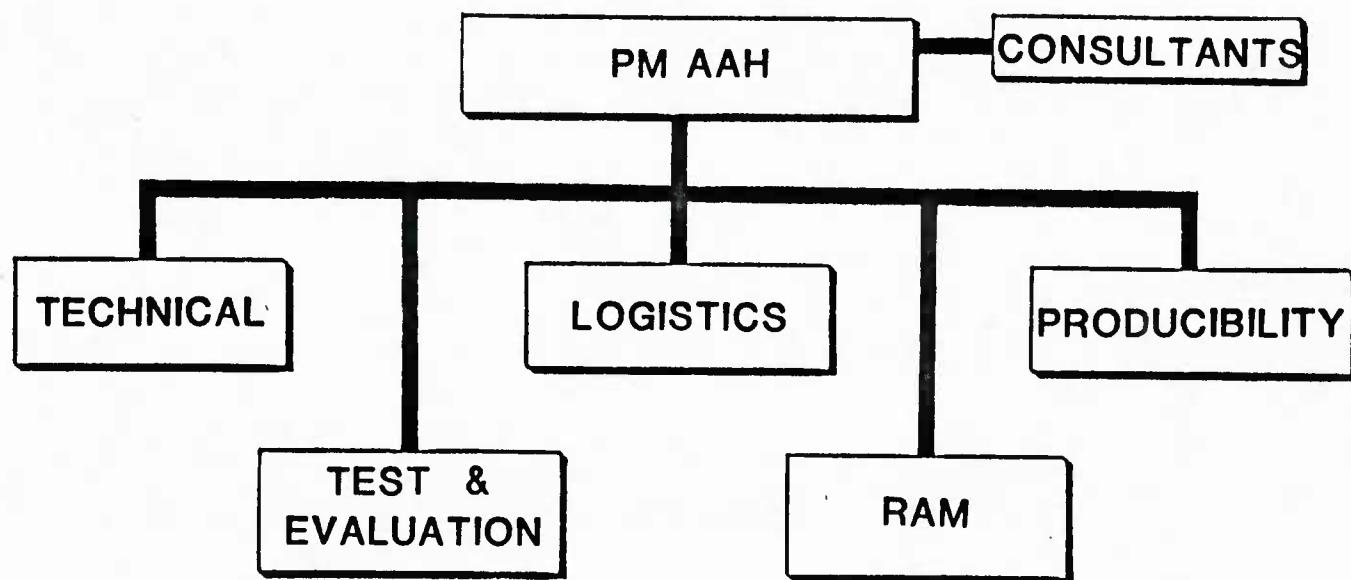


Figure E-5

AAH WORKING GROUPS



Figure E-6
ARMY AAH COMMUNITY

included the following series of reviews and tests of the prototype helicopters:

- o Preliminary Design Reviews (PDR)
- o Integrated Mockup Review
- o Critical Design Reviews (CDR)
- o Pre-First Flight Design Reviews
- o Government Testing Design Reviews
- o Monthly Technical/Flight Test Reviews
- o Government review of contractor support and airworthiness qualification testing.
- o Government DT/OT II

The transition from Phase 2 to production was smoothed by the fact that the PEP requirement was in the FSED contract. Figure E-7 shows the schedule for the AAH program transition to production.

In conjunction with PEP, the Configuration Management was a major factor in the transitioning to production. The umbrella of the AAH system covered the Configuration Management constraints imposed on Project/Product managed subsystems such as the TADS/PNVS, HELLFIRE, and the 30mm cannon. The design flexibilities of the AAH have afforded the contractor leeways in various management responsibilities, taking advantage of advanced technologies to improve the end product. This design flexibility was extended to the completion of Functional Configuration Audit (FCA), during August 1981. At that time a Contractor Design Freeze Baseline (CDBF) was established and the procedures for Engineering Change Proposal (ECP) in accordance with DoD-STD-480A were imposed. The AAH Configuration milestones are shown in Figure E-8. AAH

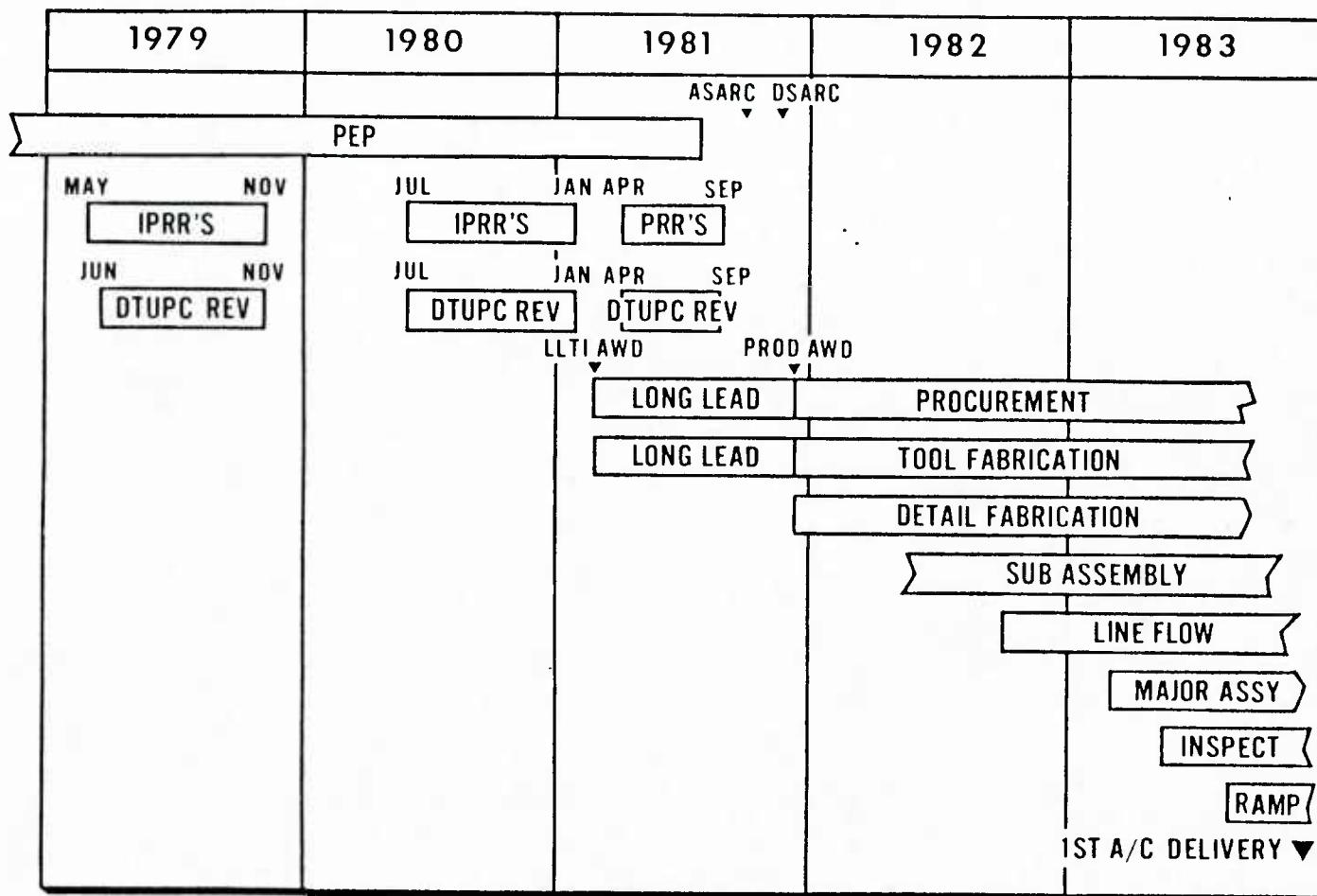


Figure E-7

SCHEDULE FOR TRANSITION TO PRODUCTION

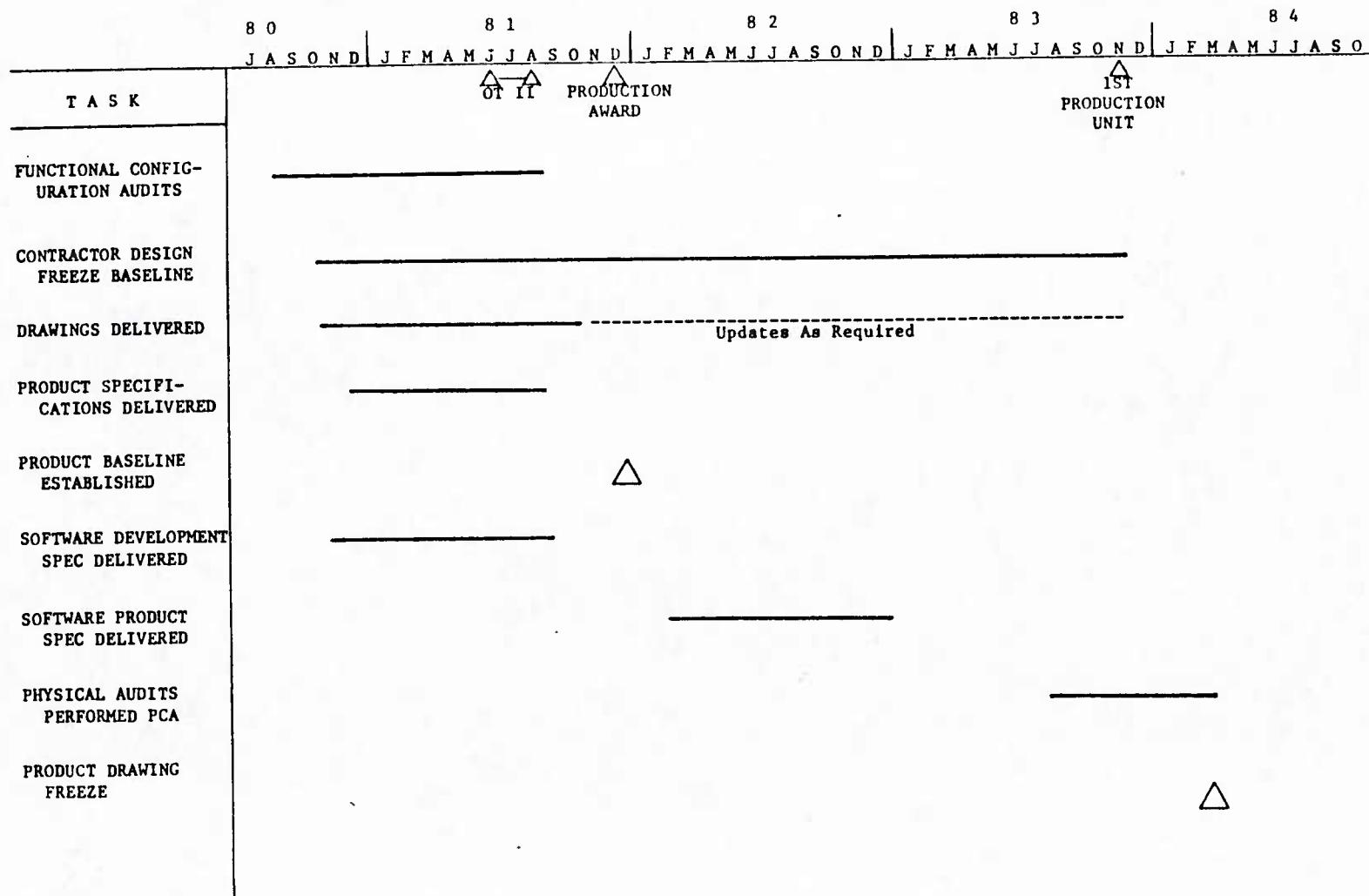


Figure E-8

CONFIGURATION MILESTONES

Configuration Control Boards were convened to review and evaluate proposed changes and to assist the PM in reaching a decision on approval/disapproval of changes. The board evaluates the impact of the changes on engineering design, engineering development, production, safety, procurement, delivery maintenance, supply support, cost, and the DTC and LCC.

The AAH Program Manager was responsible for the resolution of interface problems arising during the design, development, and integration of subsystem equipment items. Interface Control Agreements between appropriate contractors were signed and an Interface Control Working Group (ICWG) formed with Martin Marietta given the status of an associated contractor.

In April 1981, the decision was made to employ the more powerful T-700-GE-701 engine for AH-64A production. The 701 engine offered an increase of 10% shaft horsepower at 4,000 feet/95°F over the original T-700-GE-700 engine. Use of the 701 engine lead to the solution of two performance problems, 1) not meeting the Vertical Rate of Climb (VROC) requirement and, 2) not meeting the cruise speed requirement. Selecting the more powerful engine was an approach that was considerably less costly and less risky than conducting a weight reduction program--the alternative to achieving the required VROC. The cruise speed problem could have been solved with the incorporation of drag reduction fairings - but the alternate engine solution provided for greater operational flexibility due to its improved performance.

The additional cost of going to the T-700-GE-701 engine (in FY82\$) was \$54.3M in R&D, recurring, and nonrecurring costs. The AAH program benefited from the fact that the 701 engine was a derivative of the U.S. Navy T-700-GE-401 engine developed for its LAMPS III program.

d. Phase 3--Production

The initial long lead time contracts for production of the AAH (Airframe, engine, TADS/PNVS) were awarded early in 1981. The AAH will be procured sole source from Hughes Helicopter, Inc., as the prime contractor. A listing of the major contractors involved in the production of the AAH are shown in Figure E-9. The first year buy of 11 AH-64s included three separate contracts with the prime; a Fixed Price Incentive (FPI), firm target for 11 aircraft; a FPI, firm target for Logistics Support Hardware; and Fixed Price Level of effort for program support. The second year AAH buy was a separate procurement. The major milestone in the AAH production program are shown in Figure E-10. The overall AAH production schedule is shown in Figure E-11.

HUGHES HELICOPTERS, INC. (PRIME)

SUBCONTRACTORS

Advanced Structures	-- Rotor Blades
Aircraft Gear Corp.	-- Tail Rotor Gearboxes
Bendix	-- Drive Shaft
Garrett Corp.	-- Environ. Control System
General Electric	-- T-700-GE-701 Engine*
Honeywell Avionics	-- IAHDSS
Litton Guidance & Cntl.	-- HARS Strapdown
Litton Precision Gear	-- Main Transmission
Martin Marietta	-- TADS/PNVS*
Menasco	-- Landing Gear
Parker Berteau	-- Hydraulic Systems
RCA	-- Auto. Test Equip.
Singer-Kearfott	-- Doppler Nav. System
Sperry	-- Multiplex Systems, ASE
Teledyne Ryan	-- Airframe Structure
Teledyne System Co.	-- Fire Control Computer

ARMAMENTS

GFE	-- 2.75 Rockets
Honeywell Def. Sys.	-- 30mm Ammunition
Hughes Helicopters, Inc.	-- 30mm Cannon
Rockwell	-- HELLFIRE Missile

* GFE

FIGURE E-9
MAJOR AAH CONTRACTORS - 1982

AAH & TADS/PNVS IPF and LLTI Contract Award	Feb 1981
T700-GE-701 LLTI Contract Award	May 1981
Milestone III	Dec 1981
Production Contract Award Martin Marietta Corp	Apr 1982
Production Contract Award Hughes Helicopters, Inc.	Apr 1982
Production Contract Award General Electric	Apr 1982
First Production Deliveries	
TADS/PNVS	Jun 1983
AAH	Feb 1984
T700-GE-701	Mar 1983
IOC	FY85

Figure E-10
AAH MAJOR PRODUCTION MILESTONES

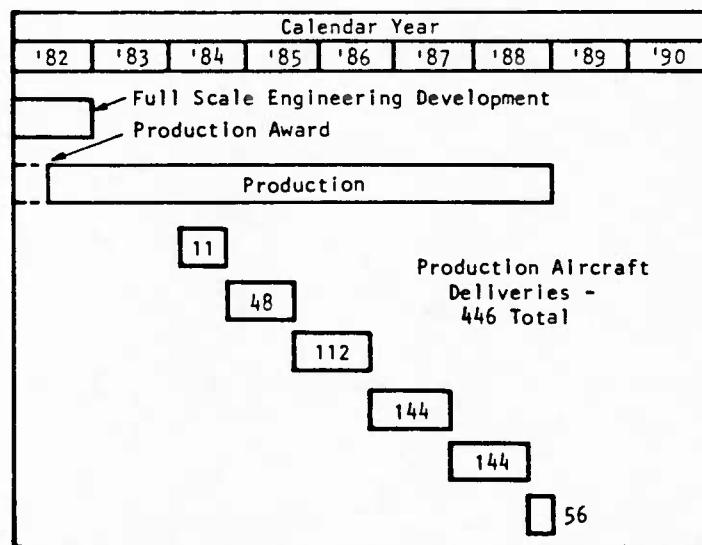


Figure E-11
AAH PROGRAM PRODUCTION SCHEDULE

As of Dec '82

2. STUDY TEAM OBSERVATIONS

a. Fabrication of prototypes during the Engineering Development (or advanced development) Phase of a program is necessary to support the decision to proceed to FSED. The translation of design to hardware suitable for government testing provides an environment in which requirement and affordability issues can be more accurately assessed.

b. When a weapon system is being developed which has many subsystems to be integrated by the prime contractor, effective interface control among contractors must be developed. Establishment of a Working Group for Interface Control and funding the contractors to interface, is one proven approach that can be taken by the PMO.

c. RFPs for competitive engineering development should not contain so many specifications that competing contractors lose design flexibility, innovative opportunities, and tradeoff capabilities.

d. A funded PEP effort in R&D concurrent with Full Scale Engineering Development, to include a manufacturing planning effort, smoothes the transition from development to production.

e. Long lead requirements can involve other than installed hardware and IPF. Items such as spares, GSE, and training devices can also require long lead funding if necessary logistics support is to be available for initial production deliveries.

f. Intensive management, as was used during Phase 2 of the AAH Program, was very successful. A PM should consider overall program status, number of

subcontractors, and the resources available and tailor his management approach as appropriate. An approach that works for one program, may not work for the next.

g. It is essential that good working relationships and rapport are developed between the PMO staff and their counterparts at the contractors' plant(s) so that the PM has confidence in the information provided to the PMO.

h. On programs involving subsystems with the criticality of TADS/PNVS to the overall program, establishment of a separate project office reporting to the system program manager, such as was done by the AAH PM, should be considered. If such an organizational concept is not used the government resources required to manage a successful program may not be available.

i. Prototyping only the airframe during the competitive Phase 1, with subsystem integration being the responsibility of the winning contractor in Phase 2, lowered the Phase 1 cost, schedule, and technical risks. However, the source selection process did not have the means to fully evaluate the contractor's ability to manage the complex subsystem integration requirements of Phase 2.

APPENDIX F
TEST AND EVALUATION MANAGEMENT

1. BACKGROUND

a. The AAH test program was designed to fully integrate the development testing performed by the contractor and by the developer to ensure efficient and effective use of prototypes and to eliminate redundant testing. Developmental test issues and criteria were in accordance with the AAH specifications. Operational test issues and criteria were developed by TRADOC, the PMO, and OTEA. Because the AAH development and system acquisition program is to provide an essential Army capability, the overriding issues were those related to the capability of the system to effectively perform in the combat environment and provide significant operational and cost advantages over alternative systems.

Figure F-1 shows the AAH Test and Evaluation Program to date. Planned tests include Contractor and Government First Article - Preproduction Testing in FY84, Production Acceptance Testing starting in FY84, Reliability Verification Testing in FY85, and an IOC/Force Development Test and Experimentation also in FY85.

b. A Test Integration Working Group (TIWG) was established by the AAH PMO in July 1975, prior to the competitive DT/OT I scheduled for mid to late 1976. The TIWG membership includes representatives of over sixteen government organizations and contractors involved with the AAH program.

In addition, the PM HELLFIRE also had a TIWG for the HELLFIRE DT/OT II. After the 1976 decision to put HELLFIRE on the AAH, the HELLFIRE and AAH TIWG meetings were each opened to the other systems PMO personnel.

1976 1977 1978 1979 1980 1981 1982

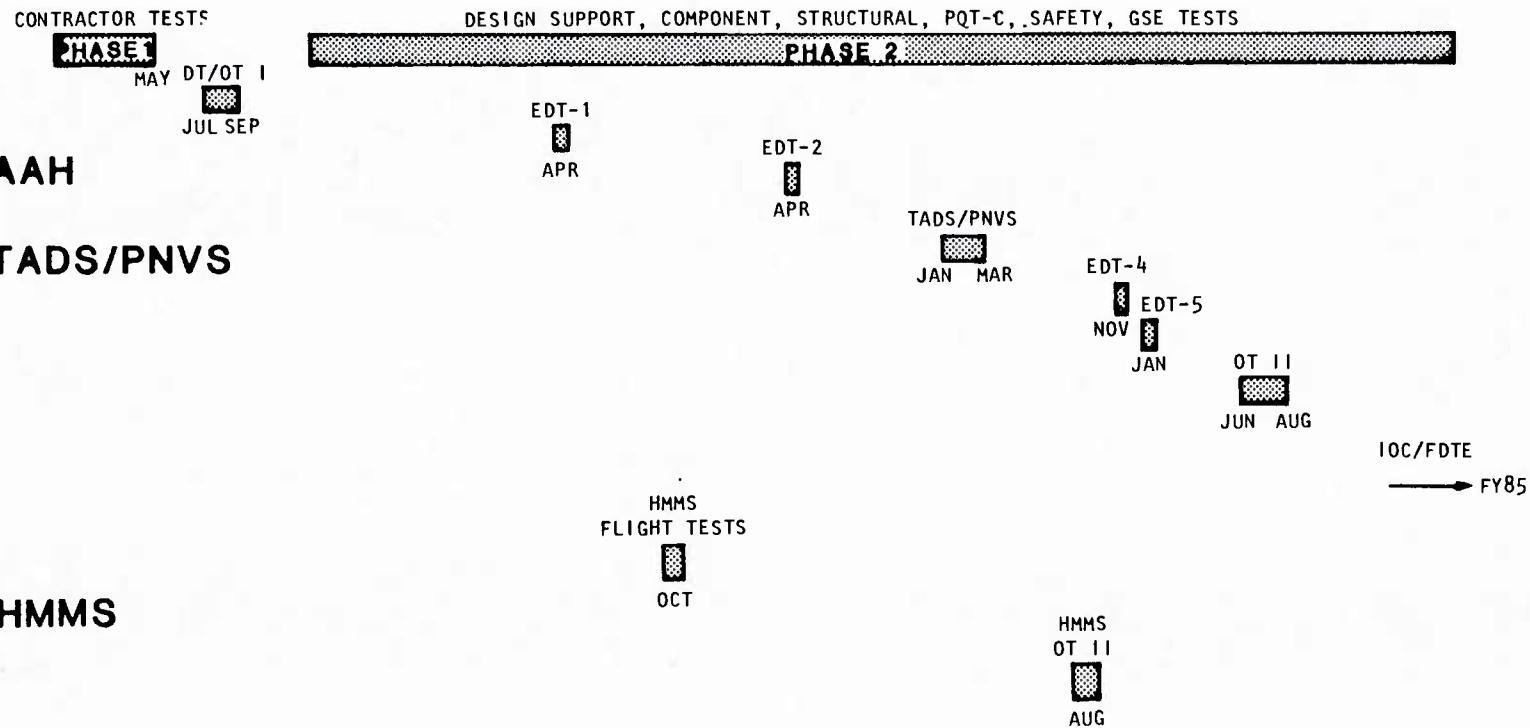


Figure F-1

TEST AND EVALUATION PROGRAM

The purpose of the TIWG is to provide a forum for direct communications to (1) facilitate the interface and integration of test requirements, and (2) expedite the Coordinated Test Program process. The objective of the AAH TIWG was to reduce costs without sacrificing quality by integrating test requirements to the maximum extent, eliminating redundancy, and eliminating potential problem areas.

c. Development and Operational Testing I

(1) Contractor Developmental Testing. Contractor competitive Phase 1 testing included design support tests, testing of individual components, establishing limited fatigue lives and bench testing of dynamic components to demonstrate sufficient structural integrity for the conduct of the Government competitive flight test program. Complete dynamic system testing was conducted utilizing the Ground Test Vehicle (GTV). Following successful completion of initial GTV qualification testing, first flights occurred on 30 September and 1 October 75 for Hughes and Bell Helicopters respectively. Each contractor completed approximately 300 hours of flight testing prior to delivery of two flight vehicles each to the Army on 31 May 76. The contractor flight testing was oriented primarily toward flight envelope development, demonstration of structural integrity, and evaluation and verification of aircraft flight handling qualities. Limited in-flight firing tests of 30mm cannons and 2.75" rockets were also conducted.

(2) Government Development Test (DT) I. DT-I was conducted by the Army Engineering Flight Activity (AEFA) at Edwards AFB, CA, in conjunction with OT I during July - September 1976. More than 90 flight hours were accumulated on each of the candidate designs. These tests were conducted pri-

marily to evaluate flight handling qualities and aircraft performance and included inflight firing of the 30mm cannon and 2.75" rockets. RAM data were obtained throughout the DT test program. DT-I results were evaluated by the SSEB to assist in selecting the contractor to proceed to Phase 2.

(3) Operational Test (OT) I. OT I compared the two candidate systems, (YAH-63 and YAH-64) with their respective baselines (each an AH-1S) under limited operational conditions to examine relative mission performance; Reliability, Availability, Maintainability (RAM) characteristics; combat survivability; and human factors data.

Tests were conducted at Edwards Air Force Base and China Lake Naval Weapons Center, CA, during the period 9 through 23 September 1976. The aircraft were tested in an airframe only configuration (i.e. without weapons and target acquisition subsystems).

The total airframe time allocated to operational flight profiles for OT I was 16 hours per candidate. Within this limited time sample, operational events included the following:

- o Hover-out-of-ground-effect (HOGE)
- o Low level (day and night)
- o Contour course (detectability testing)
- o Nap-of-the-earth (NOE) course
- o Simulated firing missions (detectability testing)

Test events were distributed between the Middle East desert type environment at Edwards and the mountainous/high altitude environment at China Lake. Aircraft were piloted by aviators from the Army Engineering Flight

Activity at Edwards. User copilots/gunners, from Fort Hood, who were proficient in nap-of-the-earth attack helicopter tactics, were used. Several user pilots were given familiarization flights but were prohibited from participation in operational testing due to safety of flight restrictions.

Test criteria (provided by TRADOC) was that the AAH, in an operational environment, should provide specified results which are judged to equal or exceed the results obtained from the corresponding baseline aircraft.

Test results, as reported by OTEA included:

(a) Performance. Overall, each candidate equalled or exceeded the performance of its baseline in the human factors ratings given by the test crews.

(b) RAM. The size of the OT I RAM data sample did not permit any statistical analysis. However, OTEA personnel monitored both DT I and OT I to subjectively assess RAM characteristics of the AAH candidates. Specific deficiencies noted in each candidate, which were judged to have adverse impact on user operation, were identified to the PM.

(c) Detectability. Measurements were made to determine the comparative visual and aural signature that the test helicopters presented to ground observers while being operated using attack helicopter tactics. The AAH was detected significantly faster than its baseline. However, the dominate visual cue was that of silhouette.

(d) Although there were test problems (limitations)¹ identified by

¹Limitations identified were lack of system cross training due primarily to lack of aircraft time; safety restrictions; RAM data restrictions; not able to test subsystems; maintenance not performed by Government personnel.

OTEA, the conclusion was that the generic AAH, under limited operational conditions, performed as well as or better than the baseline AH-1S, and was judged to be suitable for continuation to the next phase in the acquisition cycle.

d. The Development Test Training Detachment (DTTD) was activated at Edwards AFB on 1 March 1979. Although assigned to the U.S. Army Test and Evaluation Command (TECOM), it was under the operational control of the AAH PMO. The DTTD was a dedicated training detachment to support development and operational testing of the AAH. Pilots and copilot/gunners are trained on surrogate subsystems (AH-IGs and AH-ISs equipped with PNVS, ATAFCS, and HELLFIRE missile systems). The first training cycle began on 26 July 1979. The 11-week course was designed to prepare for the EDT-3 and the TADS/PNVS competitive tests. A second training cycle, early in 1980, prepared player pilots for the HELLFIRE Operational Test II and EDT 4. Later courses were conducted for the AAH Operational Test II. The use of surrogate training is an entirely new approach that provides additional equipment, operational experience, and pilot training while reducing the risk, cost, and schedule impacts of flight training operations with the AAH. Its mission completed, the DTTD was deactivated on 31 December 1981.

e. Development and Operational Test II.

(1) Engineering Design Test (EDT) 1. EDT-1, the first in a planned series of Government tests in the FSD (Phase 2) program was conducted by AEFA at the Hughes Helicopter flight test facility at Carlsbad, California, during April 1978. 21.8 flight hours were accumulated. The objectives of this evaluation were to assess the flight handling characteristics of the aircraft,

check significant performance parameters and confirm corrections of air vehicle discrepancies discovered during the Government/contractor testing. EDT-1 test results indicated that the contractor had not yet corrected all the deficiencies of the Phase 1 design.

(2) Engineering Design Test (EDT) 2. EDT-2 was conducted by AEFA at the Hughes Helicopters flight test facility, Carlsbad, California, during April 1979. 20.5 flight hours were accumulated. The objectives of the evaluation were to assess the flight handling characteristics of the aircraft, check significant performance parameters, and confirm corrections of air vehicle discrepancies discovered during EDT-1.

(3) Engineering Design Test (EDT) 3. The EDT-3 requirement was deleted during the program restructuring in July 1979.

(4) TADS/PNVS Competitive Evaluation. The TADS/PNVS competitive evaluation fly off, was conducting by the PM, AAH, assisted by TECOM at the AAH desert facility, Yuma, AZ, during January - March 1980. One YAH-64 system vehicle was utilized for each competing TADS/PNVS. Testing consisted of approximately 90 flight hours on each. TADS evaluation included system bore-sight and boresight retention, pointing, tracking, designating and rangefinding accuracy, target acquisition range, and TADS/weapon systems compatibility, sideward flight, hover, unmask and remask, and PNVS/weapon compatibility.

(5) Engineering Design Test (EDT) 4. EDT-4 was conducted by AEFA, at Carlsbad, California, during November 1980. Approximately 33 hours were flown during 27 flights. Major changes affecting performance and handling qualities were made to the YAH-64 since the last evaluation (EDT-2). These included a

new, digital stability augmentation system, and a redesigned empennage featuring an automatically programmed stabilator and an increased diameter tail rotor. Hover and level flight performance of the aircraft had been improved since EDT-2. Handling qualities were greatly improved.

(6) Engineering Design Test (EDT) 5. EDT-5 was conducted at Yuma Proving Ground, AZ, between 1 December 1980 and 27 January 1981. The YAH-64 exhibited significant capabilities and potential as an Advanced Attack Helicopter although the item tested: (1) was not completely free of defects, (2) exhibited poor reliability, and (3) did not have all systems integrated. Two new discrepancies were identified; operation and design of the fuel system and reliability of the APU starting capability. Other minor discrepancies and several enhancing characteristics were identified. All discrepancies were resolved prior to Operational Test II.

(7) 30mm Ammunition Development Program. The 30mm ammunition program developed the XM788 (TP) Target Practice and XM789 High-Explosive Dual Purpose rounds utilizing the shaped charge from the WECOM 30mm program and the fusing technology of the Bushmaster 25mm program. In addition to satisfying established requirements for the YAH-64's turreted cannon, the XM788 is used by the Marine Corps in the AV-8A Harrier aircraft, and provides for NATO interoperability among the many Armament Development Enfield (ADEN) and Direction D'Etudes et Fabrication D'Armament (DEFA) gun systems currently in use. Hughes Helicopters, the prime contractor, let a contract to Honeywell (sole source) for XM789 round development. Government testing was conducted to assure interoperability of U.S. guns with U.S. ammunition, U.S. guns with European ammunition, and European guns with U.S. ammunition.

(8) AAH/HMMS Evaluation. The independent evaluation of the AAH/HMMS by AMSAA addressed both the performance of the AAH and HMMS with respect to specific requirements set forth in the MN and DCP documents and overall weapon system performance. The assessment of the AAH/HELLFIRE indicated the potential of a unique weapon system which can effectively engage enemy armor in day and night, under clear and adverse weather conditions, in a combat environment at ranges beyond the range of key air defense threats. Realization of potential will result in a substantial extension and enhancement of current capabilities in close combat. Additionally, the weapon system offers great potential against projected armor threats, improvements in communication techniques, and exploitation of advanced technology in fields such as automatic target recognition which will further enhance the combat effectiveness of the system. A review and analysis of the test data revealed two open issues with the TADS that have since been corrected.

(9) Operational Testing II (OT II). The AAH OT II was a comparative, three-phase test conducted at Fort Hunter Liggett, CA, June thru August 1981. A typical TO&E unit provided resources for both an AH-64 test section and an AH-1S baseline section. The test section consisted of three AH-64s and two Airborne Target and Fire Control Systems (ATAFCS) equipped AH-1S to act as scouts for the AH-64s. The baseline section consisted of three AH-1Ss and two OH-58 scouts. The AH-1S and AH-64 aircraft were flown in the same operational and threat environment. The three phases of the test included a training phase, a non-live fire phase, and a live fire phase. Appropriate exploratory trials preceded each phase. Force-on-force and one-on-many engagements, with real time casualty assessment, were conducted during the non-live fire phase. The live fire phase included firing of all AAH weapons. In total, over 400

hours of flight testing was accomplished. The purpose of the test was to assess the military effectiveness of the AH-64 against the baseline aircraft. The AH-64 was also evaluated in terms of RAM, and supportability in an operational environment. All unit and the majority of intermediate maintenance was performed by trained military personnel with technical support by manufacturers representatives. OTEA was responsible for conducting the operational test with technical support from the contractor. The results of OT II showed that the performance of the AH-64 is adequate for combat, superior to the present attack helicopter, night capable, and survivable. There were no operational issues which were considered to preclude acquisition and deployment of the AH-64.

2. STUDY TEAM OBSERVATIONS

- a. Make the Prime Contractors responsible for all maintenance and test instrumentation for DT/OT I. The lack of maturity in design, and consequently maintenance procedures, makes impractical the training of Army maintenance personnel for these tests.
- b. Provide quality assurance surveillance of Contractor maintenance during the tests. This function is normally provided by the plant activity during Contractor development and must be continued during testing.
- c. Establish procedures for visitor control, public information releases, and familiarization flights. The Project Manager must exercise management responsibility in these areas to safeguard competitive sensitive information and to facilitate conduct of the tests.
- d. Establish internal accident and incident reporting procedures at the test sites. All accidents/incidents reports must flow through the Project Manager to prevent compromising a particular Contractor's competitive position and to facilitate corrective management actions necessary for the prompt resumption of flight testing.
- e. Hold at least two RAM scoring conferences during the tests. The first conference should be held near the middle of the test and the second conference held at the end. These conferences, attended by representatives from the materiel and operational developer communities, assure that a proper and consistent determination is made for categorizing RAM test data. An assessment conference should be held shortly after the tests are completed.

f. Station a Project Manager's Representative (PMR)/Contracting Officer's Representative (COR) with the test team at the test site. The PMR/COR monitors contractor support, provides interface between government testers and contractors, and monitors the status of tests for the PM.

g. Execute memorandums of agreement among all participants that establish policies and procedures for the conduct of the test. This is necessary due to the different interpretations of responsibilities outlined in both Army and DoD testing regulations.

h. Maintain flexibility in future test schedules. Prioritizing subtests is a way of ensuring that the most important results of the test are obtained as soon as possible after testing starts. Bad weather, maintenance problems, and non-productive test hours are the rule rather than the exception in test programs.

i. Fully integrate OT-I with DT-I. Operational Tests should not be separate tests but should be conducted concurrently (combined) with DT-I with user pilots flying as a mixed crew with engineering pilots whenever practical. Operational profiles can then be flown during test periods that are unsuitable for engineering type tests.

j. The AAH PM established a field office at the OT II test area. Included were PMO personnel from the logistics, test and evaluation, and technical divisions. Although controlled by test personnel, these PM representatives can improve test continuity and facilitate the flow of spares and repair parts. In fact, controlling spares and parts helps keep PMO personnel informed of what is going on.

k. The TRADOC Systems Manager also had a full time representative at the OT II test site.

l. Contractor personnel at the OT II test site included technical writers who were able to make publication changes on the spot and pass them back to the users during the test.

m. The operational tester frequently desires to restrict PMO personnel from certain test areas. As the Army's independent tester, OTEA should have that authority to control test site attendance.

n. Evaluation personnel from AMSAA should be retained to the extent possible. For example, have them contracted to do studies for the PMO. Otherwise, these teams tend to split up after completing their reports, making it difficult to track data, make corrections or changes, etc.

o. If a test report requires correction by the testing activity, have it accomplished as an addendum to the original report and distributed to all of the original addressees so that erroneous reports do not remain in circulation.

p. Operational test issues for OT I were not realistic considering the AAH program acquisition plan, the length of time available for OT, and the equipment availability. The OTEA IER was unjustifiably critical of the test limitations, the Phase 1 system/subsystem status, and the maintenance plan for OT I either because it did not understand the situation or did not agree with the plan.

q. The TIWG was an unwieldy tool in the case of developing test issues for OT. Test issues were developed among the PMO, OTEA, and TRADOC as a team

effort outside of the TIWG. (Note: The M1 program established a sub-group within the TIWG to develop OT issues.)

r. Because OTEA had its own RAM data system, the on-going TSARCOM RAM-Logistics System was halted during OT. Later the OTEA data was converted -- at a cost -- into the TSARCOM system.

APPENDIX G

INTEGRATED LOGISTICS SUPPORT MANAGEMENT

1. BACKGROUND

a. The AAH Materiel Need prepared by the AAHTF in 1972 specified logistical support concepts/requirements that were to be achieved by a mature (100,000 fleet hours) AAH system. These requirements included:

- o Have an operational availability of 0.70 to 0.80*
- o Have a probability of 0.95** of completing a one hour mission without a mission failure
- o Have a probability of 0.999952 of completing a one hour mission without a catastrophic failure
- o Be in consonance with the logistic support system at the time of its introduction and similar to that for the current attack helicopter (AH-1G) and other Army helicopters
- o Designed for austere combat zone maintainability
- o Compatible with USAF transport aircraft of the C-141 and C-5A types and appropriate USN and commercial vessels.
- o Degree of skill required at each level of helicopter maintenance should not exceed that required for current attack helicopters except as required for advanced avionics, visionics, navigational, or weapon systems
- o Total maintenance ratio at organizational, DS, and GS levels of 8.0 to 13.0 maintenance manhours per flight hour (MMH/FH)
- o Inspections limited to not more than 1.0 MMH/FH
- o Mean time to repair (MTTR) at organizational, DS, and GS of 0.65 to 0.90 hours
- o Dynamic components have a mean time between removal of not less than 1200 flight hours.
- o Major overhaul of airframe not less than 3,000 flight hours
- o Operating time of 300 hours between periodic inspections

* Operational availability deals only with one helicopter and the likelihood of its being in an operable and committable state when it is being used and maintained under field conditions.

** A mission failure is defined as any malfunction detected during operation or attempted operation which causes or may cause any of the following conditions: degradation of performance capability below designated levels; serious damage to the item; inability to commence operations; cessation of operation; or serious personnel safety hazards.

Although originally planned for the then current four levels of maintenance, the maintenance concept was changed late in 1973 to reflect the Army decision to go to the three levels of maintenance concept. The new aviation maintenance levels are:

- o Aviation Unit Maintenance (AVUM)--maintenance organic to the operating unit
- o Aviation Intermediate Maintenance (AVIM)--maintenance equivalent to direct and general support tasks. Mobile maintenance contact teams.
- o Depot Maintenance (D) - overhaul/repair of those components, assemblies, or LRUs requiring extensive skills, facilities, and equipment. Normally fixed and immobile.

The Logistic Support Analysis (LSA) requirement was also a new concept¹ that was implemented by the AAH Program in 1973 vice the Maintenance Engineering Analysis (MEA) effort referred to in the MN.

b. Logistic Support Management in Phase 1, June 1973 - December 1976

(1) Maintenance tasks required on the AAH system, including the airframe, engine, and subsystems were identified and allocated to the appropriate maintenance level through the LSA effort using LSA Data Sheets A (Operations and Maintenance Requirements), B (Item Reliability and Maintainability Characteristics), and C (Task Analysis Summary). Sheets A, B, and C were completed on approximately 400 Line Replaceable Units (LRU).

¹MIL-STD-1388-1 and -2, 15 October 1973.

(2) Support and Test Equipment requirements. The contractors furnished support and test equipment for their ground test vehicles and flight vehicles. The Government furnished support equipment for GFM as required. Design of support equipment during Phase 1 was confined to LLTI required early in Phase 2.

(3) Supply Support. Contractors were responsible to select, stock and issue spares and repair parts in support of their system. The Government was responsible for GFM requirements.

(4) Transportation and Handling. The contractors were to design the AAH for C-141 and C-5 airlift and for below deck storage on Landing Platform-Helicopter (LPH) carriers. Specific disassembly-loading and unloading-assembly maximum manhours and elapsed times were prescribed in the specifications.

(5) Facilities. PMO and contractor required facilities were provided for DT/OT I by the Aviation Test Facility, Edwards Air Force Base.

(6) Technical Data. Technical manuals were not procured in Phase 1. The contractors prepared flight manuals which were used in the tests by Government personnel.

(7) Manpower and Training and Training Devices. The contractors conducted Staff Planners Courses and operator training for pilot/gunner personnel. No maintenance training was provided to Army personnel--contractor personnel performed all maintenance during testing. No training devices were required for Phase 1.

(8) Logistic Support Management Information. The Materiel Readiness Support Activity (MRSA) logistic computer program was installed on both of the AAH prime contractor's computers. LSA worksheets were prepared by the contractors on each repairable item of his design. Government reviewers were charged with insuring that system design had considered all elements of logistic support.

c. Logistic Support Management in Phase 2, December 1976 - August 1981.

The primary emphasis in Phase 2 was the orderly design, integration, test, and qualification of the mission equipment installed on the weapons platform, along with its attendant GSE, publications, MOS skills, training material, training aids/devices, and spares and repair parts.

The AAH logistic support effort required interfacing with HQDA, DARCOM (CECOM, TSARCOM, ARRCOM, and MICOM) and TRADOC plus up to eight individual Program/Project/Product Managers to develop, provide, and evaluate an acceptable degree of weapon systems support and performance. PMs having equipment and/or responsibilities having an effect on the AAH weapons system or its support requirement were:

PM HELLFIRE

PM 30mm AMMUNITION

PM TRAINING DEVICES

PM NAVIGATION AND CONTROL SYSTEMS

PM AUTOMATIC TEST MEASUREMENT DIAGNOSTIC SYSTEMS

PM AIRCRAFT SURVIVABILITY EQUIPMENT

PM TADS/PNVS

PM MOBILE ELECTRIC POWER

The HELLFIRE ILS program was designed to meet the AAH schedule. The HELLFIRE ILSMT and the AAH ILSMT each had some participation at their meetings by members of the other PMO.

(1) Maintenance. During this phase, maintenance tasks were allocated to the appropriate levels through utilization of LSA. The use of LSA was perpetuated by the AAH contractor to encompass each of his subcontractors and vendors and their respective subs/vendors.

The maintenance concept was based on the premise that Operational Readiness (OR) and Reliability (R) were of primary importance to mission accomplishment and any maintenance specification/requirement must improve, not detract from OR and R. Accordingly, emphasis was placed on insuring that:

- o Systems trouble shooting and isolation to the faulty LRU at AVUM must be fast and accurate to minimize down time of the weapons system.
- o Quick change out of all components at AVUM was essential.
- o A reduction in false removals at AVUM level and/or quick turn around of such removals at AVIM.
- o The need for technical manuals and attendant skills must be minimized.

(2) Support and Test Equipment. GSE was identified via the LSA D Sheet (Maintenance and Operator Task Analysis) and E Sheet (Support and Test Equipment). In order to ensure the minimum use of peculiar GSE and the maximum use of existing PGSE, a highly defined system of identification, justification, and approval was established to manage the GSE program.

(3) Supply Support. The policies and responsibilities established in Phase 1 were expanded in the FSED Phase 2, i.e., maximum responsibility for accomplishing supply support was continued with Hughes who continued to func-

tion as a National Inventory Control Point and a Field Supply Activity for all tests at all test sites for both CFE and GFM. Supply support was expanded to include supporting the complete AAH weapons System (air vehicle and subsystems).

(4) Transportation and Handling. The contractor was required to demonstrate transportability of his air vehicle in a C-141 and a C-5A and, by analysis, in an LPH and over-the-road. Disassembly-loading and unloading-assembly maximum manhours and elapsed times were specified. A self-deployment range of 800 nautical hours was also required.

(5) Facilities. Facilities required for tests were contained in the Coordinated Test Plan for the AAH.

(6) Technical Data. Draft Equipment Publications were prepared in accordance with the new Skill Performance Aids format by the contractor and approved by the Government. Publications included all operator instructions and maintenance and parts manuals through the AVIM level, on the aircraft. The range of publications on the specific subsystems included AVUM and AVIM (excluding some waived items).

(7) Manpower and Training Devices. Design for support was a prime consideration during FSED. Skills, abilities, and mental and physical qualifications of operator/maintenance personnel were determined to be similar to those qualifications for the AH-1 support personnel. The contractor conducted maintenance training courses in support of the Physical Teardown-Logistics Demonstration and OT-II were government personnel performed all but Depot maintenance.

Because of the lack of adequate prototype AAH flight time available for flight training and the new, highly sophisticated systems found on the APACHE, a separate Development Test Training Detachment (DTTD) was formed. Preliminary flight training was performed using AH-1 surrogate aircraft (modified to accept TADS/PNVS and IHDSS). Each trainee received approximately 25 hours of flight time in these aircraft prior to actual AAH training (which also was approximately 25 hours at the contractor's site). In addition, each pilot, copilot/gunner received 15 hours in an Aircrew Part Task Trainer which was a fixed computer-assisted training device designed to teach switchology, starting/stopping, and emerging procedures.

Fifteen (15) prototype training devices were developed during FSED. Thirteen were for support of maintenance training and two were for support of pilot/gunner training. The training devices were:

Pilot Training

Aircrew Part Task
Pilot Night Vision System

Aircraft Equipment Type Devices

Composite
Flight Control/Powertrain
Engine/APU
Armament/Fire Control/Visionics
Integrated Avionics

Panel Devices

Fuel System
Electrical System
Mission Equipment
Hydraulic
Integrated Pressurized Air System
Automatic Stabilization Equipment
Fault Detection/Location System
De-Ice System

(8) Logistic Support Resource Funds. A total of \$121.9m was required to support the Phase 2 ILS effort by Hughes and Martin Marietta. The breakout is shown in Figure G-1.

<u>Element</u>	<u>Funding (Millions)</u>
Supply	13.6
Maintenance	13.5
Support Equipment	25.1
Publications (SPA)	20.6
Packaging, Handling, Storaging, and Trans.	1.2
Technical Assistance	
Facilities	
Personnel and Training	18.6
LSA/LSAR	<u>11.8</u>
Development, Test, and Training Detachment	<u>17.5</u>
	121.9

Figure G-1
PHASE 2 ILS RDT&E FUNDING

(9) Logistics Support Management Information. The primary management information system for the AAH logistics program was provided through automated LSA, utilizing the LSA supplemented with manually prepared supply support reports.

The contractor updated and expanded the Phase 1 prepared LSAR worksheet packages for each repairable item of his design to obtain the full range of data and worksheets. The LSAR packages were reviewed, approved or changed every 90 days through negotiation with the contractor by a Government review

team. The review team consists of maintainability engineers and provisioning technicians from ARRCOM, TSARCOM, CECOM and MICOM, and TRADOC School(s). These reviews were chaired by the Program Manager's Logistics Management Division. Team reviews insured that system design had thoroughly considered logistics plans and that programs provided data to validate the maintenance evaluation, physical teardown, publication accuracy, GSE requirements, parts requirements and usage, personnel and skills required, and maintenance manhours per flight hour. The Phase 2 LSA effort also included TADS/PNVS LSA/LSAR data integration into the LSA/LSAR master record.

Integrated Logistic Support Management Team (ILSMT) meetings were held with the prime contractor every 120 days, or as required. These meetings were intended to:

(1) Present an update of the ILS program for all Army interested parties.

(2) Review the status and adequacy of the ILS program.

(3) Surface problem areas, assign responsibility to resolve those problems, and assure their satisfactory resolution. The ILSMT meetings were co-chaired by the Army's AAH Logistic Management Division Chief and the Contractor's Product Support Chief. These ILSMT meetings served as a forum for early recognition and resolution of ILS problem areas before they became critical.

d. Logistic Support Management, Production Phase, September 1981 - present.

During Phase III the ILS effort is being directed toward:

- o Refinement of those logistical products identified, completed, and tested during Phase 2 (FSED)
- o Initiation/completion of those support products required prior to or concurrent with fielding
- o Completing the evaluation/validation of those elements not tested during Phase 2.

(1) Based on a decision made in 1981, the AAH will utilize the T-700-GE-701 engine in production aircraft. The 701 is an uprated 700 and has 90% commonality with the original engine. LSA will be accomplished on all peculiar data required to incorporate the T-700-GE-701 in the Army system. Totally new manuals, in the SPA format, will be produced for the 701 engine.

(2) The LSA program performed during the development phase will continue during the first two full-rate production years. Logistics Support Analysis (LSA) is the source data for all training activity. Through the LSA program, total requirements for AAH training support will be identified, recorded, and evaluated. One of the products of this effort is the Personnel Task and Skill Analysis Report. This report provides information on which to base changes to MOSs should they be required.

(3) The Program Manager has established the Integrated Logistics Support (ILS) concept as the method of managing the entire logistical portion of the AAH acquisition program. This effort is directed by an ILS Management Team (ILSMT). The ILSMT meets every 120 days or as required. The ILSMT is co-chaired by the Chief of the AAH Logistics Management Division and the prime contractor's Product Support Manager. Personnel and training is a functional logistics element which will be monitored by the ILSMT.

(4) Personnel and training specialists from all training activities (TRADOC, PM TRADE, Service Schools, etc.) have participated and will continue to participate in the personnel and training planning for the AAH program. These specialists attend ILSMT conferences, as well as training meetings at various Army locations and the contractor's sites. During these meetings, information and data is disseminated to assist these specialists in the execution of their responsibilities, i.e., providing training input from LSA, refining Quantitative and Qualitative Personnel Requirement Information (QQPRI), developing schools training requirements, etc. Participants will also provide assistance, guidance and decisions in their particular areas as the program progresses.

(5) It is planned to have positive AAH MOS identification to preclude loss of skills in the system. This will provide identification of AAH trained personnel during early stages of fielding. It will provide the Program Manager with the means of locating AAH personnel in the event of their transfer to other units.

(6) Extension Training Materials (ETM) were procured in conjunction with the Skill Performance Aids (SPA) type of equipment publications. Extensive use of SPA will reduce the scope of TRADOC service school training without degradation of skill proficiency. SPA equipment publications can be used to provide OJT to maintenance personnel in AAH units. The ETM provides testing and accreditation of proficiency in qualifying maintenance personnel. ETM constitutes a part of the training package development requirement. The unique feature of SPA/ETM is that training can be accomplished either in an operational unit or a TRADOC service school.

(7) Training device requirements have been expanded to include four individual size panel devices. The aircrew devices are now called the Cockpit Weapons Emergency Procedures Trainer (formerly Aircrew Part Task Trainer) and the TADS/STT (formerly Pilot Night Vision System Trainer).

(8) Fielding of the AAH. The AAH PM established an APM-Logistics position during development. The APM's emphasis now is on fielding preparations. A draft Materiel Fielding Plan (MFP) is expected to be ready in February 1983 for TRADOC. Later, MFPs for USAREUR and FORSCOM will be prepared. The MFP was written using the guidance contained in DARCOM Circular 700-9-4, Instructions for Materiel Fielding, April 1982 and reviews of the MFPs prepared for the UH-60 and the CH-47. HQDA established the "Systems Fielding Readiness Assessment Group" with membership from HQDA, DARCOM, TRADOC, FORSCOM, and USAREUR to make recommendations to the VCSA regarding fielding of the M1 Abrams Tank System. A similar group has also become involved with the AAH fielding. Early in 1983, the PMO will establish a Fielding Branch within the Logistics Management Division.

2. STUDY TEAM OBSERVATIONS

a. To preclude "throwaway" costs associated with the Phase 1 "loser", maximum responsibility for logistic support of their prototype vehicle was placed on the contractors. Fabrication of peculiar support equipment was, along with technical manuals and training devices, deferred until Phase 2.

b. ILS funds were also saved during the competitive Phase 1 because the two contractors were not required to train Army maintenance personnel during the Phase.

c. It took too long to obtain additional personnel for the Logistic Management Division in anticipation of the fielding requirement. Seven more personnel are due in February 1983, nearly four years after the first efforts to increase the division size to handle the additional workload.

d. The LSA effort would have been better had:

- o The contractors been forced to hire adequate LSA personnel early on
- o Budget provisions been made for LSAR computer changes which are inevitable with a program that was neither mature nor stabilized
- o The Government had sufficient leverage to make the contractor do what he offered in the LSA Plan
- o LSA been fully funded throughout Phase 1, and kept that way
- o The contractor had better coordination between his design and maintainability engineers

e. Current spares requirements should be based on current expected failure rates, not on the maturity rate which might not be reached for several years.

f. The Government recognizes the importance of ILS but industry generally doesn't share the government view. Because of the many \$ in O&S (spares, repair parts, GSE, etc.) industry should recognize the profit potential and thus the importance of ILS.

g. Understanding the magnitude of the LSA effort is important to RFP preparation by the Government, proposal preparation by industry, and the source selection process. The LSA effort can be more accurately scoped through study of like and similar equipment, help from MRSA, help from Readiness Commands, and engineering experience and judgement.

h. The establishment of the DTTD was a practical solution to preparing aircrews for the total AAH weapons systems tests without using limited AAH assets.

APPENDIX H

GENERAL OBSERVATIONS

The following study team observations cover issues that do not clearly fall within anyone of the functional areas included in the preceding appendices. These issues range from the handling of RSI matters to internal program office management concerns.

1. The M1 Abrams Tank System and the AAH programs had many similarities. The PMs established a program that brought personnel from each office together to discuss their problems, solutions, and observations. Although the schedule of meetings was overtaken by the press of events, many PMO personnel continued to talk by telephone and there were many benefits from the program.

2. The use of Government experts and consultants to overcome technical or management problems is a means of supplementing the PMO and contractor resources as well as gaining new insights. However, their use should be controlled by the PM to assure it is limited to specific problems and their relationship to contractors and subcontractors explicitly defined and controlled.

3. The success of a weapons system acquisition program is as dependent upon overcoming the chaos of the Federal budgetary process, the degree of agreement obtained among executive departments, and the leadership of the PM as it is upon the hardware development program.

4. The successful Project Manager should be assigned to a program for the longest practical period and, at a minimum, a PM should carry a program through a complete acquisition phase.

5. Nearly every system document prepared by a PMO or by another command or activity includes a system description, program history, and other general background information. Each presentation is different and some are erroneous. A single authoritative and periodically updated document should be prepared to cover these subjects. It can then be included as an attachment or reference. Examples of documents containing histories, descriptions, etc. are: Test Design Plans, Coordinated Test Plan, Test and Evaluation Master Plan, Integrated Program Summary, ILS Plan, Test Reports, Independent Evaluation Reports.

6. The PM should be an enthusiastic salesman of his system (with discretion). He should make people aware of what the system can do, take it to conventions, military bases, and other countries.

7. Because Hughes had little international weapon systems marketing experience, the PMO set up a task force comprised of his personnel, contractors, and subcontractors to promote the AAH as a total system. An Assistant PM - International Operations position was established in 1982 to coordinate international matters.

8. The PMO took advantage of the experiences of other PMOs in an effort to better understand potential customers, their politics, etc.

9. Although a program may not be formally classified as multinational, consideration of RSI is still a requirement. The PMO should develop an RSI plan - such as the HQDA approved AAH RSI Plan. The RSI Plan increases the potential for achieving greater RSI through a common/interoperable air vehicle to satisfy NATO requirements. In addition, the existence of an approved plan facilitates the responses to and handling of RSI issues.

APPENDIX I

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The following list of references identifies publications used in the preparation of this report. In addition to these publications, there are many DOD and Service instructions, regulations, handbooks, letters and memoranda that were reviewed and which are mentioned in the report at relevant places in the text.

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APPENDIX J

GLOSSARY OF ACRONYMS

AAFSS	- Advanced Aerial Fire Support System
AAH	- Advanced Attack Helicopter
AAHTF	- Advanced Attack Helicopter Task Force
ADEN	- Armament Development Enfield
AEFA	- Army Engineering Flight Activity
AHIP	- Army Helicopter Improvement Program
AMC	- US Army Materiel Command
AMSAA	- US Army Materiel Systems Analysis Activity
APA	- Aircraft Procurement Army
APM	- Assistant Program Manager
APU	- Auxiliary Power Unit
ARRADCOM	- US Army Armament Research and Development Command
ARRCOM	- US Army Armament Materiel Readiness Command
ASA	- Assistant Secretary of the Army
ASARC	- Army System Acquisition Review Council
ASH	- Armed Scout Helicopter
ATAFCS	- Airborne Target and Fire Control System
AVIM	- Aviation Intermediate Maintenance
AVRADCOM	- US Army Aviation Research and Development Command
AVUM	- Aviation Unit Maintenance
BCE	- Baseline Cost Estimate
BG	- Brigadier General
CAIG	- Cost Analysis Improvement Group
CDC	- US Army Combat Developments Command
CDFB	- Contractor Design Freeze Baseline
CDR	- Critical Design Review
CECOM	- US Army Communications Electronics Command
CERCOM	- US Army Communications and Electronics Material Readiness Command
COEA	- Cost and Operational Effectiveness Analysis
COR	- Contracting Officer's Representative
C/SCSC	- Cost/Schedule Control Systems Criteria
CTP	- Coordinated Test Plan
DA	- Department of the Army
DARCOM	- US Army Materiel Development and Readiness Command
DASC	- Department of the Army System Coordinates
DCP	- Development Concept Paper
DEFA	- Direction D'Etudes et Fabrication D/Armament
DEPSECDEF	- Deputy Secretary of Defense
DOD	- Department of Defense
DSARC	- Defense Systems Acquisition Review Council
DSCLOG	- Deputy Chief of Staff (Logistics)
DSMC	- Defense Systems Management College
DT	- Development Test
DTC	- Design to Cost
DTTD	- Development Test Training Detachment
DTUPC	- Design to Unit Production Cost
ECOM	- U.S. Army Electronics Command
ECP	- Engineering Change Proposal

ED	-	Engineering Development
EDT	-	Engineering Development Test
ERADCOM	-	US Army Electronics Research and Development Command
ETM	-	Extension Training Materials
FCA	-	Functional Configuration Audit
FD/LS	-	Fault Detection/Location System
FDTE	-	Force Development Testing and Experimentation
FARP	-	Forward Area Replenishment Point
FFAR	-	Folding Fin Aerial Rocket
FLIR	-	Forward Looking Infrared
FORSCOM	-	US Army Forces Command
FPI	-	Fixed Price Incentive
FR	-	France
FSED	-	Full-Scale Engineering Development
G&A	-	General and Administrative Expenses
GAO	-	General Accounting Office
GE	-	Federal Republic of Germany
GFE	-	Government Furnished Equipment
GSE	-	Ground Support Equipment
GTV	-	Ground Test Vehicle
HAC	-	House Appropriations Committee
HASC	-	House Armed Services Committee
HOGE	-	Hover Over the Ground Effect
HMMS	-	Hellfire Modular Missile System
HQDA	-	Headquarters, Department of the Army
ICP	-	Inventory Control Point
ICWG	-	Interface Control Working Group
IER	-	Independent Evaluation Report
IFF	-	Identification Friend or Foe
IHADSS	-	Integrated Helmet and Display Sight System
ILS	-	Integrated Logistics Support
ILSMT	-	Integrated Logistics Support Management Team
IOC	-	Initial Operational Capability
IPF	-	Initial Production Facilitization
IPS	-	Integrated Program Summary
IR	-	Infrared
LDNS	-	Light Weight Doppler Navigational System
LEA	-	US Army Logistics Evaluation Agency
LLTI	-	Long Lead Time Items
LOI	-	Letter of Instruction
LPH	-	Landing Platform Helicopter
LRU	-	Line Replaceable Unit
LSA	-	Logistics Support Analysis
LSAR	-	Logistic Support Analysis Record
MDBS	-	Multiplex Data Bus Subsystem
MEA	-	Maintenance Engineering Analysis
MFP	-	Materiel Fielding Plan
MG	-	Major General
MICOM	-	US Army Missile Command
MLRS	-	Multiple Launch Rocket System
MMH/FH	-	Maintenance Manhours per Flight Hour
MM&T	-	Manufacturing Methods and Technology
MN	-	Materiel Need
MOS	-	Military Occupation Specialty

MRSA	- US Army Materiel Readiness Support Activity
MSC	- Major Subordinate Command
NATO	- North Atlantic Treaty Organization
NOE	- Nap of the Earth
OR	- Operational Readiness
OSD	- Office of the Secretary of Defense
OT	- Operational Test
OTEA	- US Army Operational Test and Evaluation Agency
P3I	- Preplanned Product Improvement
PCO	- Procurement Contracting Officer
PDLTI	- Prototype Development Lead Time Items
PDR	- Preliminary Design Reviews
PEP	- Producibility Engineering and Planning
PGSE	- Peculiar Ground Support Equipment
PM	- Project/Program Manager
PMO	- Project/Program Management Office
PMR	- Project/Program Manager's Representative
PNVS	- Pilot Night Vision Sensor
PQT	- Production Qualification Test
PR	- Program Review
PRR	- Production Readiness Review
QMDO	- Qualitative Military Development Objective
QMR	- Qualitative Material Requirement
QQPRI	- Quantitative and Qualitative Personnel Requirement Information
RAM	- Reliability Availability and Maintainability
R&D	- Research and Development
RFP	- Request for Proposal
RS I	- Rationalization, Standardization and Interoperability
SA	- Secretary of the Army
SAC	- Senate Appropriations Committee
SASC	- Senate Armed Services Committee
SAR	- Selected Acquisition Report
SCA	- Should Cost Analysis
SDDM	- Secretary of Defense Decision Memorandum
SECDEF	- Secretary of Defense
SINCGARS	- Single Channel Ground and Airborne Radio System
SPA	- Skill Performance Aids
SSEB	- Source Selection Evaluation Board
TADS	- Target Acquisition Designation Sight
TECOM	- US Army Test and Evaluation Command
TEMP	- Test and Evaluation Master Plan
TIWG	- Test Integration Working Group
TOW	- Tube-Launched, Optically Tracked, Wire-Guided Missile
TRADOC	- US Army Training and Doctrine Command
TRASANA	- US Army TRADOC Systems Analysis Activity
TSARCOM	- US Army Troop Support and Aviation Material Readiness Command
USAREUR	- US Army, Europe
USDR&E	- Under Secretary of Defense for Research and Engineering
UTTAS	- Utility Tactical Aircraft System
VCSA	- Vice Chief of Staff, Army
VROC	- Vertical Rate of Climb
WECOM	- US Army Weapons Command

APPENDIX K
STUDY TEAM COMPOSITION

1. TEAM LEADER

Lieutenant Colonel Garcia E. Morrow is assigned to the Research and Information Department, Defense Systems Management College, Fort Belvoir, VA. He graduated from St. Lawrence University in 1963 with a Bachelor of Science degree. Following graduation, LTC Morrow entered the U.S. Army as an Air Defense Artillery officer. He is a graduate of the U.S. Army Guided Missile Staff Officer Course and has had R&D assignments with the Pershing, Sergeant, Lance and SAFEGUARD Systems. LTC Morrow was also the Team Leader for the Lessons Learned Report prepared for the Multiple Launch Rocket System (MLRS) in 1980.

2. TEAM MEMBERS

a. Mr. Charles M. Lowe, Jr., is a Procurement Analyst with the U.S. Army Procurement Research Office, U.S. Army Materiel Systems Analysis Activity, Fort Lee, Virginia. He earned a BBA from East Texas State University in 1974, an MBA from Southern Illinois University in 1977, and an MS in Procurement and Contract Management from Florida Institute of Technology in 1978. Mr. Lowe has worked on APRO studies in the areas of Government furnished equipment, administrative leadtime costs and improvements, and acquisition of advertising services. He was a Logistics Specialist and Procurement Analyst with the Troop Support and Aviation Readiness Command (formerly the Troop Support Command) prior to joining the APRO.

b. Mr. Elmer H. Birdseye is a retired U.S. Army Officer who is currently employed as a management analyst with Information Spectrum, Incorporated

(ISI), Arlington, VA. He is a 1951 graduate of the United States Military Academy. He received a Master of Engineering Administration degree from the George Washington University in 1968. Mr. Birdseye's military experience includes service with field artillery howitzer and rocket units; R&D staff officer in the Office of the Deputy Chief of Staff for Research and Development, Department of the Army; and as the U.S. Army Field Artillery Standardization Representative to the United Kingdom. Mr. Birdseye was also a Team Member for the Lessons Learned Report on MLRS.